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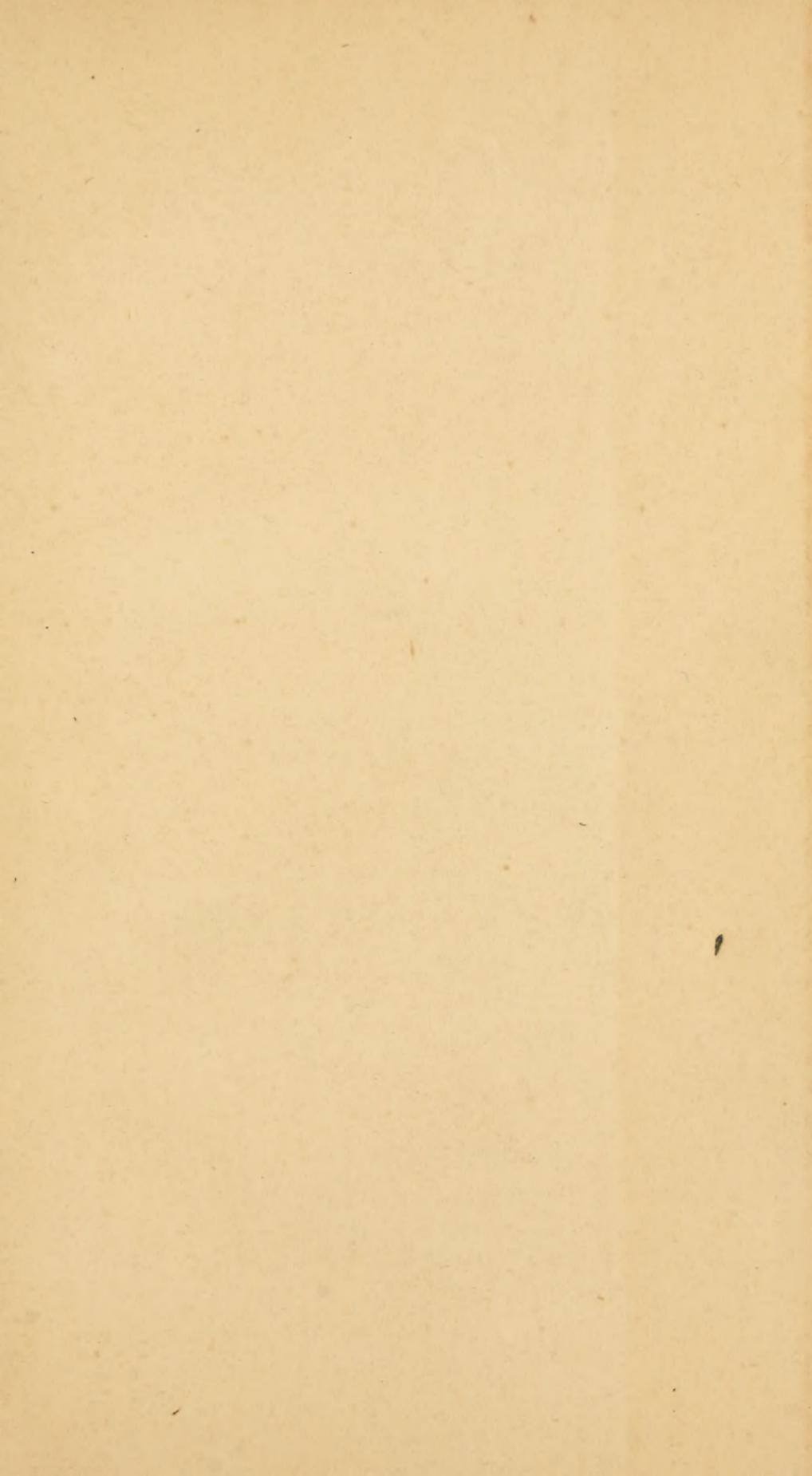
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No. B 48

UNITED STATES OF AMERICA.









A BOOK FOR EVERY BOY IN THE COUNTRY.

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ELEMENTS  
OF  
AGRICULTURE:

FOR THE  
USE OF PRIMARY AND SECONDARY SCHOOLS.

BY  
L. BENTZ, OF FRANCE,

Director of the Normal Primary School of the Meurthe, Member of the Royal and Central Societies of Nancy and Aurillac.

AND

A. J. CHRETIEN DE ROVILLE,

Professor of Rural Economy in the same School, Member of the Agricultural Society of Nancy, &c., &c.

APPROVED AND RECOMMENDED BY THE GOVERNMENTAL COUNCIL  
OF THE DEPARTMENT OF THE MEURTHE.

TRANSLATED AND ADAPTED TO THE USE OF THE RURAL PRIMARY SCHOOLS OF THE

UNITED STATES OF AMERICA.

BY F. G. SKINNER.

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## REPORT

### MADE TO THE CENTRAL AGRICULTURAL SOCIETY OF THE MEURTHE.

GENTLEMEN:—Two of your new colleagues, Mr. Bentz, Director of the Normal Primary School of the Department of the Meurthe, and Mr. Chretien, Professor of Rural Economy in the same school—both honorary members of the Central Agricultural Society of Nancy—have just published an elementary work on the science that you cultivate. I have been appointed to examine, and report upon this work—a duty that I most cheerfully undertake. I must, however, be first permitted to declare, that with me it is a subject of some delicacy, inasmuch as I have myself published two works having the same object in view with that of Messrs. Bentz and Chretien; it shall not, however, prevent me from stating candidly the impression made upon my mind by their publication.

I have read, with attention and continued interest, the “Elements of Agriculture for the Use of Primary Schools.” The first observation that struck me was, that they had been faithful to their title-page. Thus, we find nothing in their work that is not absolutely elementary, but sufficient, nevertheless, for the object in view. The teacher may with confidence draw upon its pages for all that seems to be of primary necessity, for himself first, and then for the children or adults confided to his care. Another thing that we remarked on opening the new work of our honorable colleagues, is the insertion at the end of each subdivision of a chapter, of a series of questions, so skilfully put, as to compel the reader or scholar to review, involuntarily as it were, the subject upon which his attention has for a moment been directed. This is a happy idea—an innovation that may bear good fruit; and we do not hesitate to aver, that the complete absence of replies seems to us the more judicious, as it compels, in the formation of these replies, an exercise of both the judgment and memory. You will not fail to remark, gentlemen, that there must inevitably result to the pupil, from this method of proceeding, three important advantages—the obligation to read attentively each lesson; the

compulsory exercise of two intellectual faculties, the development of which is in a direct ratio with the use that is made of them; and finally, the habit of rendering to ourself an account of what is read—a species of exercise that leads to thought and meditation.

The division adopted by the authors seems to us simple, proper, and logical. In the first part, they commence by giving us all the requisite knowledge of natural history, and then some general ideas on the cultivation of the soil, the physiology and anatomy of plants, and finally on vegetable reproduction. The second part is devoted to the study of the soil in general, and to that of its physical properties. The different operations required to bring the soil into cultivation, manures, ameliorators, and stimulants, are the objects of the third part. Under these different titles are arranged the subdivisions, skilfully treated, and entirely within the comprehension of the young readers, for whom the book is destined.

The publication of the second volume depends, the authors tell us, upon the reception that may be given to the first. This reserve, full of modesty and good taste, reveals to the Society not only the value of its new colleagues, but the zeal with which it should encourage and promote their labors. However, gentlemen, this sympathy and encouragement have recently been generously manifested, by the governmental council of our department, for the elementary work that we have the honor to report upon; the council having ordered the expenses of printing the work to be defrayed out of the fund appropriated by government for the encouragement of agriculture.

If, on the one hand, this intelligent vote is a just and proper reward for a useful work, it will also enable its publishers to furnish it at a less cost than they otherwise could. Thus, gentlemen, by our co-operation with the general council of the department, we at once render an act of justice to the authors, and make manifest the interest that we feel, not only in the teachers and the scholars of the country, but also in the success of primary and secondary instruction in matters appertaining to agriculture.

C. MANDEL.

Report adopted, and ordered to be printed.

DEDICATED,  
BY THE TRANSLATOR,  
WITH UNAFFECTED RESPECT, AND A HIGH SENSE OF THE  
TRUE DIGNITY OF THEIR PROFESSION,  
TO  
THE TEACHERS OF YOUTH  
IN  
THE UNITED STATES:

The followers of a pursuit the most responsible and honorable, when properly understood; and yet, in proportion to its importance, the least honored and the worst paid, of all others.

## P R E F A C E.

WHEN it is considered that a very large majority of the millions who are constantly in training at our country schools are to be cultivators of the soil, and that on their general intelligence, with some knowledge of the principles of their own profession, must in a great measure depend, not only the prosperity of American agriculture, but the permanence of our free institutions ; every lover of his country must reflect with regret on the want of more diffusive and perfect systems of general education, and especially on the absence of a *plain, intelligible, elementary work on the principles of agriculture*, for the use of our common schools. This want, it is now confidently believed, has been supplied by what is here offered, entitled "ELEMENTS OF AGRICULTURE FOR THE USE OF COMMON SCHOOLS," which has lately appeared in France, under the auspices of the department for public instruction, and been sanctioned, as will be seen, by the strong recommendation of men of the highest distinction and authority for learning and benevolence.

This little work is purely elementary in its character, and so plainly written, that while the principles are brought within the comprehension of children who ~~were~~ attained their twelfth year, it can not fail to be entertaining and auxiliary, if not instructive to their teachers. If in itself it does not make those who study it accomplished agriculturists, it will at least pave the way for their becoming such, by explaining the rudiments of those sciences with which Agriculture is naturally connected.

As will be perceived, by reference to the table of contents, the work is divided into three Parts. The first treats of NATURAL HISTORY, explaining, in a clear and simple manner, the difference between ORGANIC and INORGANIC SUBSTANCES, Animal and Vegetable Life, Vegetable Reproduction, &c. The Second Part treats, in like perspicuous and intelligible style, of CLIMATE, and its effects upon animal and vegetable life. MINERAL MANURES, more properly called by the French writers *ameliorators*, and ANIMAL and VEGETABLE MANURES, with their management and application, make up the Third Part. Finally, it has been slightly modified, as was needed, to adapt it to the soil and climate of the United States.

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## PART FIRST.

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### CHAPTER I.

*General Notions on the Art of cultivating the Soil, and  
of the different Objects that exist in Nature.*

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#### LESSON I.

##### DIVISIONS IN THE ART OF CULTIVATION.

1. *The Art of Cultivation.*—The object of this art is to obtain from the earth the greatest possible quantity of products; and it is usually divided into four parts, namely: 1. Agriculture, or the cultivation of fields. 2. Horticulture, or the cultivation of gardens. 3. The cultivation of the grasses. 4. Arboriculture, or the cultivation of trees.

2. *Agriculture.*—The principal aim of agriculture is to produce those plants that are most generally used as food, by man and domestic animals; such as wheat, Indian corn, rye, barley, oats, as also potatoes, beets, turnips, clover, lucerne, etc. Among the products of agriculture are also to be classed what are called the industrial plants, such as flax, hemp, cotton, hops, madder, and others that furnish materials for different manufactures, either at home or abroad. Thus we see that agriculture is the chief foundation of a nation's power, as it not only furnishes man with food and clothing, but also with materials for the mechanic arts, and commerce.

3. *Horticulture* has for its object the cultivation of vegetable gardens, and orchards. It flourishes most in the vicinity of cities, as there it not only finds a ready market for its products, but an abundant supply of manures. It is by means of horticulture that the greatest quantity possible of products is obtained ; for several crops are usually taken from the same ground, in the same year.

4. *Arboriculture* treats of the planting, growth, and management of trees. It is a branch of agriculture that will increase in importance with the decrease, now so rapidly going on, in the timber throughout the country.

5. The cultivation of the grasses, for pasturage and hay, is of such well-known importance, that it will be separately treated in this work.

This work is specially devoted to agriculture and rural economy.

6. A knowledge of the principles that it may be necessary to follow in cultivation, is called the theory ; the application of these principles to cultivation, is called practice ; and he who applies them, is called an agriculturist or farmer.

7. In the theory and practice together, consists the art of cultivation. To be a good farmer, it is not only necessary to possess a knowledge of the theory, but also to know how to put it in practice.

#### QUESTIONS.

1. In what does the art of cultivation consist ?
2. How is it divided ?
3. What is the principal object of agriculture ?
4. What is theory ?
5. What is practice ?
6. What is a farmer ?
7. Does it require a knowledge of the practice and theory both, to make a good farmer ?

## LESSON II.

## THE DIFFERENT OBJECTS EXISTING IN NATURE.

8. THE art of agriculture requires some knowledge of the different objects that exist upon the surface, and in the interior of the earth. It presupposes, consequently, some acquaintance with natural history, and principally with botany, a science that treats of plants and their properties.

9. All bodies that exist upon the surface, or in the interior of the earth, are divided into three classes, called the kingdoms of nature, namely: 1. The animal kingdom, which includes man and all animals. 2. The vegetable kingdom, in which are included all vegetables, from the largest tree to the smallest plant. 3. The mineral kingdom, to which belong all rocks, stones, earths, and metals.

10. Among the beings that exist, some are endowed with life, such as men, animals, vegetables, or plants; the others are inanimate, or without life, as minerals, rocks, earths, etc. The first are called *organic bodies*; the second, *inorganic bodies*.

11. The organs are those parts of a body created for the maintenance of life.

12. It is easy to establish the distinction that exists between the beings of the three kingdoms. Those that belong to the animal kingdom grow, live, feel, and are gifted with the faculty of moving themselves, or *locomotion*. Those of the vegetable kingdom grow, and live; a proof of this last property is the faculty that they possess of nourishing and reproducing themselves. Those of the mineral kingdom grow only, and this growth takes place in a manner contrary to that of organized bodies. These last increase always from the interior to the exterior, whereas minerals increase by the addition to their surface of small particles that adhere to them.

13. The life of animals and vegetables exhibits a difference worthy of remark ; it is that vegetables seem to be endowed with the reproductive power in all their parts. Thus, when the limb of a tree is cut off and planted in the earth, it may produce another tree. This is not the case with animals.

14. Minerals, and other brute bodies, united in large masses in the bosom of the earth, form rocks that are in a continual state of decomposition. The particles derived from this decomposition constitute, by their mixture with organic remains, the different species of soil that are cultivated. In other words, *soils are composed of a mixture of organic and inorganic remains.*

#### QUESTIONS.

1. The art of agriculture presupposes a knowledge of what ?
2. What is botany ?
3. Into how many kingdoms is nature divided ?
4. What are organic and inorganic bodies ?
5. What are organs ?
6. How do we distinguish between the beings of the three kingdoms ?
7. How do inorganic bodies increase ?
8. What remark can be made upon animal and vegetable life ?

## CHAPTER II.

*Vegetable Anatomy and Physiology.*

## LESSON III.

## THE ORGANS OF PLANTS.

15. To enable the farmer to obtain the greatest possible yield from his land, it is necessary that he should know the different plants that can be cultivated to the best advantage, according to the circumstances in which he finds himself placed. It is equally useful to know how to distinguish the hurtful plants, or weeds, that flourish in his soil. To this end, some notions of botany are necessary ; for it is this science (see No. 8) that teaches us the nature and properties of plants. It is particularly when we wish to study the nature of a soil, or introduce a new plant into cultivation, that we feel the importance of a knowledge of botany. Soils, as they may be calcareous, clayey, or sandy, are more favorable to the growth of one plant than another ; and it is by an examination of the spontaneous growth, that we are enabled to recognise, almost to a certainty, whether such a grain, or such a plant, will thrive in our soil.

16. Botany is divided into several parts ; but those that it is the most important to examine here, are *the anatomy and physiology of plants.*

17. *Vegetable anatomy* treats of the division of the organs of plants, and of their respective positions. *Vegetable physiology* treats of the functions of these organs, and teaches how plants are nourished and reproduced.

18. All the organs do not fulfil the same functions : some serve for *nutrition* — that is to say, they procure for

the plant the food that it requires; the others serve for their *reproduction*

19. The *root*, the *stem*, and the *leaves*, are the organs of nutrition. Those of reproduction are the *flowers*, the *fruits*, and the *seeds*. There are, however, as we shall see, when we come to study each one of these organs separately, several that serve, at the same time, for nutrition and reproduction.

#### QUESTIONS.

1. Why is some acquaintance with botany necessary to the farmer?
2. What does vegetable anatomy treat of?
3. What is the object of vegetable physiology?
4. Do all the organs fulfil the same functions?
5. Which are the organs of nutrition?
6. Which are the organs of reproduction?

---

### LESSON IV.

#### THE ROOT.

20. THE root is that part of a plant that generally introduces itself into the soil, and there sucks up a portion of the substances necessary to the nutrition of the plant. By penetrating into the earth, it serves at the same time to support the plant in position.

21. The whole surface of the root does not concur equally in the function of nourishing the plant. Its extremity is endowed with a greater power of suction than the other parts. The mouth that is supposed to exist at the extremity of roots, is called *spongiole*.

22. There are vegetables, the roots of which do not penetrate the earth, but grow upon other plants. These vegetables are called *parasites*. The mistletoe, that we see upon so many trees, is a plant of this kind.

23. That part of a plant immediately between the ~~two~~

and the stem, is called the collar, or neck. Beneath the neck, branch off the small roots, or rootlets, that penetrate the soil in every direction, in search of the organic or inorganic substances that serve as food to the plant.

24. With regard to their duration, roots may be divided into two classes: 1. *Annual roots*, those that perish after having borne seeds, such as corn, carrots, beets, etc. 2. *Perennial roots*, those that live an indefinite number of years, as lucerne, for instance. An annual plant may often be rendered perennial by preventing its ripening its seeds, for it is in forming and maturing the seed that a plant exhausts itself, and perishes.

25. Roots, as regards their shape, may be arranged in four principal classes, namely: The tuberous, like potatoes; the fibrous, formed of small threads that spread at short distances into the soil, like those of wheat; the bulbous, resembling the onion in shape; and the tap-rooted, the most of which are fusiform, such as the beet, carrot, parsnip, etc. From these four kinds, all other varieties seem to be derived.

26. Those plants that are cultivated for their roots are of vast utility, not only as food for man, but also for domestic animals. The cultivation of the potato, the beet, and the turnip, on a large scale, has been of incalculable value to the crowded population of Europe, and has more than once saved them from the horrors of famine. Indeed, the flourishing condition of the agriculture of England is based almost entirely upon their growth. It is to be desired that the American farmer should give them more attention; independent of their value in themselves, their cultivation is the best preparation that land can receive for any other succeeding crop. Roots are drilled, worked with a hoe, the weeds are destroyed, and the land is left clear.

## QUESTIONS.

1. What is the root?
2. Does the whole surface of the root contribute to the nourishment of the plant?
3. What is the spongiole?
4. What are parasitical plants?
5. What is the collar, or neck?
6. What is an annual root?
7. What is a perennial root?
8. How may an annual be sometimes made perennial?
9. How may roots be classed?
10. Why is it advisable to cultivate roots?

---

## LESSON V.

THE STEM AND LEAVES—FUNCTIONS THAT THEY FULFIL  
IN THE ACT OF NUTRITION.

27. THAT part of the plant which, starting from the collar, springs erect above the surface of the ground, in search of light and air, is called the stem.

28. Stems are divided into several kinds, depending upon form and substance. Those resembling the stems of trees, bear the name of *trunks*; and those that are hollow and jointed, are called *stubble*, as the stems of wheat, and other cereal plants. There are plants without any stems.

29. When a stem has the consistency of wood, it is called *ligneous*; when it is tender, like grass, it is called *herbaceous*.

30. The parts composing the stems are much more difficult to distinguish in some plants than in others. Thus, in herbaceous plants, they are not easily detected; whereas in trees, we may almost always distinguish the different parts composing the stem.

31. The trunk, or stem, is divided into the following parts: 1. A dry, leathery, tough membrane, the *cuticle*. 2. A cellular layer, adhering to the cuticle, and called the

*cellular integument.* 3. A *vascular layer.* 4. A whitish layer, apparently of a fibrous texture, the inner bark, which is of a more complicated structure than the other layers. Then the imperfectly formed wood, called *alburnum*; the wood itself; and finally the pith.

32. The leaves are those parts of the plant attached to the stem, or branches, and from which they generally become detached every year. Some are united to the vegetable by means of a stem, called footstalk; and others are attached immediately to the plant, without any intervening link. Many naturalists suppose that it is through the under sides of their leaves that plants absorb the gases that aid in their nutrition.

33. Vegetables procure the elements of their subsistence not only through their roots, but also through their stems and leaves, which in this case play a very important part. They absorb, through their pores,\* the nutritious gases contained in the atmosphere. The quantity, more or less, of these principles absorbed, depends upon the organization of the plant, the manner of its cultivation, and the state of the atmosphere.

34. It is principally hydrogen and azote, combined in the shape of ammonia and carbonic acid,† that is absorbed

\* The minute particles that compose a body are called molecules, and the interstices, or open spaces between these molecules, are called pores. All bodies have pores, and are on that account called porous.

† Air is composed of two principal bodies, *oxygen* and *azote*. The result of a combination of oxygen with a simple body, is called an acid. Acids are easily recognised by a sour taste, and the property which they possess of turning vegetable blues to red. Their names differ as the quantity of oxygen entering into their composition is greater or less. Thus, when it exists in the greatest proportion possible, we terminate the name of the simple body in *ic*: but if the quantity of oxygen is not so great, the name of the simple body is terminated in *ous* — e. g., *sulphuric acid*, *sulphurous acid*: *nitric acid*, *nitrous acid*. When we burn a match, we obtain *sulphurous acid*, and sulphuric acid is the liquid substance usually called oil of vitriol. If the body formed by the combination of oxygen with another simple body does not possess the properties indicated above, it is called an *oxyde*. Among the

by plants, either through their roots, stems, or leaves. This last gas, that never enters into the composition of the air in a greater degree than a hundredth part, performs an important part in the act of vegetable nutrition, on account of the carbon that it contains. This body is found, in large quantities, in plants submitted to decomposition or combustion.

35. Carbonic acid, formed of carbon and oxygen, is decomposed, according to some naturalists, in the inner bark; the carbon becomes fixed in the plants, and the oxygen escapes. This decomposition, however, can not take place unless the plant is submitted to the influence of light; in the contrary case, the carbonic acid is expelled by the stems and the leaves, just as they received it.

36. Thus we are taught that it would be highly imprudent to sleep in an apartment containing many plants. The air, vitiated by the great quantity of carbonic acid discharged by the plants, might become exceedingly dangerous to the sleeper.

oxydes, there are some that restore the blue color that has been reddened by the action of acids. Their names differ, according to their degree of oxygenation; thus we say, protoxyde, deutoxyde, peroxyde of iron, agreeably to the degree of oxygenation of the metal.

Salts are formed by the union of acids and oxydes; and they derive their names from their constituent parts. If the termination of the acid is in *ic*, it is changed into *ate* — if in *ous*, into *ite*. The name of the acid thus modified is followed by the name of the simple body that enters the oxyde to form that of the salt; thus we will say, carbonate of lime, or carbonate of iron, agreeably as the carbonic acid shall have united itself with lime or iron to constitute the salt — sulphate of lime, or sulphite of lime, as we may have employed sulphuric or sulphurous acid to form the combination.

#### QUESTIONS.

1. What is the stem?
2. What is the trunk?
3. What is stubble?
4. What is a ligneous stem?
5. What is an herbaceous stem?

6. Of what parts is the stem formed ?
7. What are the leaves ?
8. What is the footstalk ?
9. By what means do plants supply themselves with nourishment ?
10. Why does carbonic acid play a great part in the act of nutrition ?
11. Where is it decomposed ?
12. That this decomposition shall take place, what is necessary ?
13. Why should we avoid sleeping in an apartment filled with plants ?

---

## LESSON VI.

### THE ORGANS OF REPRODUCTION.

37. THOSE are called organs of reproduction, by which a plant reproduces others of its kind. The most essential are the *stamens*, or male organs ; and the *pistils*, or female organs.

38. The pistil, which is usually found in the centre of the flower, is fecundated by a species of dust, called *pollen*, which escapes from the stamens at the moment of blooming. These essential organs of reproduction are detected in almost any flower ; the pistils are in the middle, surrounded by the stamens. When these last alone exist in a plant, it never produces seeds ; and so the result would be, were we to suppress the upper part of the pistil, which is destined to receive the fecundating powder.

39. The lower part of the pistil is called *ovule*, or *germ*. It is the germ which, in consequence of fecundation, yields the fruit. This last is nothing more in botany than a fecundated germ, or ovule, arrived at maturity.

40. There are some plants whose flowers contain both the pistil and the stamens ; these are called *hermaphrodites*. In other plants the pistil is found on one flower, and the stamens on another, but upon different stems. This occurs sometimes, however, upon the same stem. Thus with the oak : flowers with the pistil grow upon one

branch, and those with stamens on another; but with hemp, for instance, these reproductive organs are upon different stalks. When the two organs are found upon the same stalk, though in different flowers, they are called *monœcia* (one-housed plants); when upon separate and distinct stalks, *diœcia* (two-housed plants).

41. When plants of the same family are cultivated in the vicinity of each other, it frequently happens that their produce differs from the parent plant, because it partakes of the nature of both. This is particularly the case with the cabbage family. We then say that *hybridation* has taken place. Hybrid plants, in the vegetable kingdom, are what mules are in the animal kingdom.

#### QUESTIONS.

1. What is meant by organs of reproduction?
2. Which are the most essential?
3. What is a pistil?
4. Where are the stamens?
5. What is the pollen?
6. What is the germ, or ovule?
7. What is the fruit?
8. What plants are called hermaphrodites?
9. What *monœcia*?
10. Plants called *diœcia*, what are they?
11. What is the meaning of *hybridation*?

---

#### LESSON VII.

##### FRUIT.

42. A FRUIT is divided into two parts: 1. The *pe*, *carp*.  
2. The *seed*.

43. The pericarp is that part which, in a pear or an apple, is destined to be eaten. In the interior of the pericarp exists a cavity, lined with a thin membrane. It is in

this cavity that the seeds are found, which in the fruits above mentioned are called *pips*.

44. If we examine the seed well, we will find that it is composed of a pellicle enclosing another part, called the *almond*. It is within this almond that we find the embryo, containing the germ of the new plant.

45. When the seed is placed in circumstances favorable to its development, it germinates, and gives birth to the *radicle*, that plunges into the earth to form the root, and the *plumicle*, that grows upward to form the stem.

46. The first leaves that appear, after germination, are called *cotyledons*; and if a plant has but one of these leaves, it is called a *monocotyledon*: if it has several, it is called a *dicotyledon*. Plants that spring up without leaves, are called *acotyledons*.

#### QUESTIONS.

1. Into how many parts is the fruit divided?
2. What is the pericarp?
3. Where is the seed found?
4. What is the seed composed of?
5. What is the embryo?
6. What is the radicle?
7. What is the plumicle?
8. What are cotyledons?
9. What a monocotyledon?
10. What a dicotyledon?
11. What are acotyledons?

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#### LESSON VIII.

##### GERMINATION.

47. WHEN a seed is put in the ground, the moisture causes it to swell; the pellicle that surrounds it is weakened, and the embryo bursts through. Vegetation then

proceeds in two opposite directions, forming the radicle below, and the plumicle above.

48. Germination, then, is the act by which a seed, placed in the soil under favorable circumstances, develops itself, in order to give birth to a plant of the same kind as that whence it sprang.

49. That a seed may develop itself, and form a vegetable, it is not only necessary that it should be placed in the soil, and that the soil should contain the *humus* and mineral substances\* required for the nutrition of the plant, but there must also be a concurrence of certain atmospheric influences, that perform an important part in the phenomena of vegetation. These atmospheric influences, or agents, are heat, moisture, air, and light.

50. The success of germination and vegetation depends upon a union of heat and moisture. Those spots always exhibit the finest vegetation in which we find these two agents united. If, on the contrary, one of them should preponderate for a sufficient time, the plant would suffer, and finally perish. It is to establish the relation between heat and moisture, that we water plants in dry seasons. It is a common practice to soak seeds before sowing or planting them, to hasten their germination ; but the utility of this practice is more than doubtful ; for at the moment of sowing one thing or the other occurs—either the soil is sufficiently moist, or it is too dry. In the first case, steeping the seed would be useless ; in the other, vegetation would suffer, after germination, for the want of moisture.

51. Air is also indispensable to germination, on account of the combination of the oxygen which it contains with the superabundant carbon enclosed in the seed. It is

\* When vegetables or animals die, they are decomposed, and their forms changed. The product of this decomposition is called *humus*. Thus, all manures put in the soil become humus.

equally useful to plants; for without it they could not grow. Air, however, is not always favorable to vegetation: if stagnant, it is fatal; if too brisk (as is sometimes the case on high hills), it is injurious, as it causes the plant to transpire too freely, without yielding it anything in return. Air, by its weight, acts as well upon vegetable as upon animal economy. By its pressure upon the pores, it prevents the escape of the sap and blood from the vessels in which they are enclosed. Plants perspire most during the continued prevalence of dry winds. On the approach of a storm or gust, the air is particularly favorable to the development of plants; for then it is warm, and holds suspended a vast quantity of vapors. The vicinity of cities, and generally of those places where much gas is generated by the decomposition of organic bodies, is stimulating to vegetation.

52. Without light, germination can take place, but vegetation can not; or at most it will be very feeble, and the plant will soon perish. The flavor and color of fruits are due to the influence of light upon the plants producing them. A plant deprived of light will be pale and of little consistence. So, when we heap earth upon celery-plants, the object is to deprive them of light, that they may bleach. The outside leaves of a drumhead cabbage are green; but the inner leaves, that are deprived of light, are white.

#### QUESTIONS.

1. How does germination take place?
2. What is germination?
3. Is the soil alone all that is necessary to the germination of plants?
4. What is humus?
5. Besides the soil, what other agents are necessary to the development of plants?
6. What is necessary to make the germination and vegetation perfect?
7. Why is air indispensable to plants?
8. Is the air always favorable to vegetation?
9. When and where does air stimulate vegetation?
10. Is light necessary to plants?

## MORAL REFLECTIONS.

We have seen, in the lessons of the second chapter, the different parts of which a plant is composed—the root, stem, leaves, fruit, etc. If we consider the organization of plants, the structure of their parts, their astonishing variety, from the most humble herb to the majestic tree; if we consider their utility, and the benefits they confer upon man and the whole animal race, we will discover everywhere the most marvellous order, and the hand of Infinite Wisdom. We behold a seed planted in the earth, put forth roots, a stem bearing buds, branches, leaves, flowers, and fruits, in which are enveloped the germs of new plants. If, of all the wondrous works of the Creator, we were to see but this, it would be sufficient to convince us of his power and his infinite bounty. It is for us, and as it were without our concurrence, that nature, or rather a benevolent God, acts upon this earth. It is for man that the fields, gardens, and forests, abound in blessings that would be lost did he not make use of them. Let us not be insensible to so much kindness; but let us render thanks to Him who bestows so much and such constant care on our existence, and who watches over our welfare with such **sleepless solicitude.**

## CHAPTER III.

*The Reproduction of Vegetables.*

## LESSON IX.

## REPRODUCTION BY GENERATION.

53. PLANTS are reproduced by their seeds, stems, limbs, and even leaves (as is the case with the cactus). A majority, however, of cultivated vegetables spring from the seeds. It is by this mode of reproduction that we preserve, in most plants, their vigor, strength, and fructuous powers; for it is well known that many vegetables, propagated for several generations by means of their branches, become finally barren.

54. When a plant is perpetuated by means of its seeds, as is the case with wheat, rye, etc., we call it *reproduction by generation*; and we say that the reproduction is by *propagation*, when it is any other part of the vegetable than the seed that concurs in the formation of the new plant. Thus, it is by propagation that the limb or cutting of a tree produces another tree.

55. In the reproduction by generation, we must above all things be careful in the selection and preservation of the seed. That they may unite all the qualities requisite to reproduction, it is indispensably necessary that they should be thoroughly ripe, and well preserved. We should above all things prevent their getting heated, in which case they would either not sprout at all, or produce but feeble plants. A common mode of testing the quality of seeds, is to throw them into water; those floating upon the surface being considered worthless. But another, a better

method, and a more certain test of the germinating faculty is to place the seeds in a saucer, between two pieces of cloth saturated with water. After a time equal to that which seeds usually require to sprout in the earth, we may judge of the quality of those under trial.

56. Some seeds retain the germinating faculty a long time; but it is considered safer, particularly in field culture, to use fresh seeds. It has been remarked that fruit accruing from old seeds, that had retained their germinating power, are better than those furnished by new seeds; these last producing more vigorous stems and leaves. Most plants come well from the seed; some trees only thrive best from another method of reproduction.

57. It is often advantageous to set apart certain rich spots of ground as nurseries, or plant-beds, in which the seed is sown. After the plants attain the proper size, they are transplanted to where they are to remain permanently. This is the method pursued with tobacco, cabbages, etc.

#### QUESTIONS.

1. In how many ways are plants reproduced?
2. What is reproduction by generation?
3. What is reproduction by propagation?
4. What should be particularly attended to in reproduction?
5. What are the requisites of good seed?
6. How can seeds be tested?
7. What are the results obtained from old and new seeds?
8. What is a nursery, or plant-bed?

## LESSON X.

## REPRODUCTION BY PROPAGATION—LAYERING

58. THERE are four principal modes of reproduction by propagation, namely: 1. Layering. 2. By cuttings. 3. By grafting. 4. By inoculation.

59. Layering consists in bending down the branches, limbs, or suckers, without separating them from the parent plant, and covering them with soil; their extreme ends only being left out. Thus buried, they will generally soon strike root; some particular trees, however, with extreme difficulty. Such must be tongued — an operation which consists in cutting the layer half off, and splitting it up an inch or more; the cleft to be kept open by a small wedge, and buried beneath the surface. This operation should be performed in spring; and the plant, when well rooted, may be separated in the autumn or spring following.

60. By cuttings. There are many plants that may be raised from cuttings. For trees, cuttings should generally be from eight inches to a foot in length, cut off at the bottom, close below an eye, and planted in a humid soil, two thirds of their length beneath the surface, and the ground trodden hard. With some particular kinds, however, it is necessary to square the bottom of the cutting, and press it hard down on the bottom of a pot. Other kinds must be planted in pure sand, and protected from the sun till rooted. They require artificial heat in the soil, and a confined atmosphere, which moderates their transpiration.

## QUESTIONS.

1. How many modes are there of reproduction by propagation?
2. What are layers?
3. When a layer takes with difficulty, what is done?
4. When should layers be made, and when cut off?
5. How should cuttings be prepared and planted?
6. What is the treatment of those cuttings that do not take readily?

## LESSON XI.

## MULTIPLICATION OF PLANTS BY GRAFTING.

61. GRAFTING consists in placing a branch or *twig* of one vegetable upon another, in a way to cause the branch or twig to produce a new plant, with more valuable products.

62. The plant grafted upon is called the *stock*; the plant grafted, the *scion*. Grafting is particularly useful to perpetuate certain vegetables, that are by nature endowed with peculiar properties, that would be lost were the plant continued by means of the seed.

63. Professor Thouin has described forty modes of grafting: we will describe here three — *cleft-grafting*, *grafting by approach*, and *root-grafting*.

64. *Cleft-Grafting*.—This mode of grafting is usually practised on stocks of from one to two inches in diameter. It is thus performed: The head of the stock is carefully sawed or cut off, at a part free from knots, and the top pared smooth. With a thin knife, split down the stock through the centre, to the depth of about two inches; insert a wedge to keep it open for the reception of the scion. The scion is to be prepared in the form of a wedge, with an eye, if possible, in the upper part of the portion thus formed. Perfect success is the more certain when this is the case. The scion is now carefully inserted, so that the inner bark of the scion and the inner bark of the stock may both exactly meet. In large stocks, sometimes four scions are inserted. The whole is now to be carefully covered with the grafting clay, except two or three eyes of each scion.

65. *Grafting by Approach*.—This is often resorted to with plants that succeed with difficulty by other modes. The limb or limbs of each plant, which are to be thus

united, must be prepared with a long, sloping cut, of several inches, nearly to the centre ; and the part of each plan thus prepared are to be brought together and firmly secured by a bandage, so that the bark shall exactly meet on at least one side ; they are then covered, at the junction, with clay or composition. When a complete union has taken place, the trees are separated with a knife, by cutting off the scion *below* the junction, and cutting off the stock *above*.

66. *Root-Grafting*.—This operation is often performed on grape-vines, just below the surface of the earth, by the usual mode of cleft-grafting. It is also performed on portions or pieces of root, where suitable stocks are scarce.

#### QUESTIONS.

1. What is meant by grafting ?
2. How is the plant grafted upon called ?
3. What is the scion ?
4. Why is grafting particularly useful ?
5. How many modes of grafting are there ?
6. Describe cleft-grafting.
7. How is grafting by approach performed ?
8. Describe root-grafting.

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#### LESSON XII.

##### INOCULATING.

67. INOCULATING is the operation of transferring any desirable variety of tree upon the stock of an inferior variety. The operation is principally practised on small trees, and only during the time when the sap flows freely, and chiefly during the months of August and September.

68. Select for the buds the ripest young twigs of the year, and cut off the leaves, leaving the footstalk entire. Having selected a smooth place in the stock, make a per-

pendicular slit downward, quite through the bark, an inch or a little more in length. Make a cross cut at the top of this slit, quite through to the wood, a little slanting downward. Next raise the bark on each side of the slit, from top to bottom, taking care not to injure the sap-wood. Proceed then quickly to take off a bud. This is done by entering the knife about half an inch below the bud, quite through the bark, and separating the bark from the wood, to the same distance above the eye; always leaving a very thin slip of wood, about one third the length of the bud. This thin slip of wood occupies the middle section of its length. The bud is to be immediately inserted in the stock to the bottom of the slit, and between the bark and the wood; the top of the bud being squared even with the cross cut, every part, except the eye, is firmly bound, and covered with baize matting.

69. When the season is far advanced, and the sap flows less freely, it is best to take out the whole of the wood, leaving always the root of the bud. The string is usually taken off in about ten days. In the succeeding spring, when the frost is out of the ground, and the buds begin to swell, cut off the stock, about a quarter of an inch above the bud, sloping downward on the opposite side.

#### QUESTIONS.

1. What is inoculation?
2. On what is it usually practised, and when?
3. How is the operation performed?
4. When is it best to take all the wood from the bud?
5. When is the string to be taken off?
6. When and how is the stock to be cut off?

## PART SECOND.

## CHAPTER I.

## LESSON I.

GENERAL CONSIDERATIONS OF THE SOIL, AND THE CAUSES  
THAT AFFECT ITS VALUE.

1. THAT portion of the earth turned up by the plough, and in which plants are developed, is called the *soil*.
2. That portion of the earth which is not cultivated, and which lies immediately beneath the soil, is called the *sub-soil*. In certain cases, it is advantageous to bring a portion of the sub-soil to the surface, which is effected by deeper ploughing or digging than usual ; the depth of the soil is increased, and by this means better crops are obtained. We will see presently, however, that there are circumstances in which the soil would not be at all benefited by this course.
3. The soil is formed of two kinds of principles : some are of vegetable and animal origin, the others are of mineral origin. These last form the earth properly so called, and constitute the activity of the soil ; the first its richness.
4. That a soil may yield abundant crops, it is necessary that its activity should be in proportion to its richness ; but it is generally the first quality that predominates, in which case the yield is but little.
5. From what precedes, we must see that almost all soils must differ in value ; for it is rare to find two precisely alike as regards composition. In some (and it is

the smallest number), the richness (organic remains) is in excess, though in very variable proportions. In others there is an excess of mineralogical principles. In either case the cultivator is the loser; for in the first soils, most crops would *lodge*,\* and on the second the vegetation would be thin and meager.

6. We must not conclude that the nature of the soil and the proportion of its constituent elements alone influence its value. Without doubt, these causes contribute much; but there are many other circumstances, such as the exposure and depth of the soil, and the nature of the sub-soil, that in a greater or less degree affect the value of land. Thus, a lot in which the soil is not more than four inches deep, is not near so valuable as one in which it is a foot deep, though the soil is precisely alike in each. The value of land may also be affected by the nature of the sub-soil, for if it be impervious to water, the plants may suffer from too much wet; if too porous, they may suffer in seasons of drought; and finally the sub-soil may contain mineral principles inimical to vegetation.

7. It results from what we have just said, that the classification of soils can not depend upon the relative proportions of the elements of which they are constituted, notwithstanding the contrary opinion, emitted by some eminent writers. It is only by the cultivation of a farm, by a close examination of its condition in all seasons, wet and dry, and by the consideration of other circumstances that we shall indicate hereafter, that we can form an estimate approximating its real value.

\* When the growth of grain is too highly stimulated by manure, or any other agent, the stems do not acquire sufficient consistence or strength to maintain an erect position; they fall down, and this is called *lodging*.

## QUESTIONS.

1. What is the soil?
2. What is the sub-soil?
3. May the depth of the soil be increased?
4. Into how many classes do we divide the constituents of the soil?
5. That a soil may be fertile, what is necessary?
6. What is the defect in too rich a soil?
7. How is the vegetation in a poor soil?
8. What are the qualities to the value of a soil?
9. Can a soil be classed according to the relative proportion of its constituent parts?
10. Which is the best way to determine the value of a farm?

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## LESSON II.

## THE MINERAL PARTS OF THE SOIL.

8. As we have before said, the soil is composed of some substances of mineral and others of vegetable and animal origin. These last accrue from the organic remains of the vegetable and animal kingdoms, and are decomposed upon and under the surface of the earth, or have been thrown upon the fields by the cultivator. That they may produce a proper effect, it is necessary that they should be mixed with mineral substances; for alone they would be injurious to plants, as they would render vegetation too active.

9. Among the mineral substances that enter into the composition of soils, and those that are the most frequently found, and in the greatest quantity, are, *silex*, or *silicious sand*; *alumine*; and the *carbonate of lime*.\*

10. The other bodies that also enter into the composition of the soil, but less frequently and in less quantity, are, sulphate of lime,† or plaster; carbonate of magnesia;

\* Carbonate of lime is formed by the union of carbonic acid with oxyde of calcium, or with lime. All bodies thus formed by the union of an acid and an oxyde, take, as we have said before, the name of a salt.

† A salt formed by the union of sulphuric acid and lime.

oxyde of iron; and oxyde of manganese. These last two are the only mineral parts that give color to the soil.

11. If the whole of the soil was formed of one of these elements, it would be completely barren; it could only be rendered fit for cultivation by mixing with it a sufficient quantity of earth.

12. Soils that contain much silex are called light, or sandy; those, on the contrary, that contain much clay,\* are called strong, stiff, or clayey.

13. A clayey is much more compact and tenacious than a sandy soil. It is almost always very difficult to work; whereas a light soil is easily worked, at all times.

14. The different soils, then, may be divided into three classes, as regards their tenacity, or the difficulty of working them, and their fitness for one vegetable rather than another: 1. Silicious, or light land. 2. Loamy land, or that which is brought to a medium consistence, either by amendments, by manures, or even by cultivation. 3. Stiff, or clayey lands. There are, however, several other divisions admitted, depending upon the nature and quantity of the constituent elements of the soil. Thus those are called calcareous soils, which contain carbonate of lime; peaty soils are those which contain peat; ferruginous or ocherous soils, those which contain iron or ochre; and finally those are called alluvions, that are formed by the deposites of streams and rivers,— and these are usually the best for cultivation.

15. If it is useful to be thoroughly acquainted with the properties of the constituent elements of a soil, it is less with a view to appreciate the value of the land, than to ascertain what ameliorators† should be employed in its improvement.

\* Clay is a combination of alumine and silex.

† We designate as *ameliorators* those substances which, placed in the soil, change its nature, by rendering it more friable, or more compact. Thus,

## QUESTIONS.

1. Whence come the organic substances found in the soil?
2. What mineral elements are found in the earth in the greatest quantity?
3. Which are those more rarely found?
4. In which case is the soil entirely barren?
5. What is a light soil?
6. What is a stiff soil?
7. Which are the most difficult lands to cultivate?
8. Into how many classes may soils be divided?
9. What is understood by calcareous soils?
10. What by loamy land?
11. Which is the best to cultivate?
12. Why is it particularly useful to be familiar with the properties of the constituents of a soil?

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## LESSON III.

## SILEX, OR SILICA.

16. SILEX, or silicious sand, is composed of two elements—oxygen, and a metal called silicium. This metal is found in the common flint, in almost a pure state. It is not soluble in water, and can only be decomposed by fluoric, or phosphoric acid. An earth is recognised to be silicious when, mixed with water, it will not work into a paste.

17. Silica is very generally diffused throughout the earth. It is met with, in greater or less quantities, in almost all soils; and when not in excess, so far from being injurious, it is beneficial to the soil, by rendering it lighter, easier to work, and more favorable to vegetation.

18. But when sand predominates in a soil, it communicates defects that diminish its value. Crops upon it are exposed to suffer from drought, because silica does not

lime is an ameliorator, by the property which it possesses of rendering stiff lands of easier cultivation, and giving more compactness to lands that are too light.

combine with water; and the least heat causes it to lose the little moisture that it might possess.

19. Sandy lands do not easily combine with manures, the soluble parts of which are either carried off by rains, or filtrate through the sub-soil. This renders it necessary to put on weak manures, and renew them frequently.

20. Sandy lands, being very friable, do not require much work; for we would thereby increase a porosity already too great, and render the roots of the plants cultivated in them liable to exposure. To avoid this difficulty, these lands are often left in pasture for several years; sometimes they are rolled, after being sown, to render them more compact; or sheep are penned upon them. In the latter case, the soil is improved in two ways; by the tramping of the sheep, and by their droppings. Sandy lands possess the advantage of clayey lands, in being at all times in a condition to work without injury.

21. Sandy and gravelly soils differ in value, agreeably to the state of the silica, and the proportion in which it is combined with other elements. When they are composed of coarse sand and pure gravel, they are of little or no value; for they will yield but poor crops, even with a great outlay in manure. Some writers have advised these lands to be converted into meadow; but this can only be done (if then at a profit) where they can be easily irrigated; for without the necessary moisture, most of the natural meadow-grasses would speedily perish, in seasons of drought.

22. Of the cereals, rye is almost the only grain that succeeds well in sandy lands; wheat, and even barley, do not thrive on them. But Indian corn, buckwheat, and root crops, with plenty of manure, will do very well. Crops ripen earlier in these soils; but their early maturity is sometimes at the expense of their quality. Root crops grown upon them, if not so heavy, are more nutritious

than those grown upon stiff lands, because they are less watery.

23. Silica is found in the ashes of almost all vegetables, but principally in those of the cereals. This is why it has been supposed that it concurs in the nutrition of plants, although from its nature it does not seem fit for this function. In all cases, its principal function is to act mechanically upon the soil.

#### QUESTIONS.

1. Of what is silica composed?
2. How is a silicious soil recognised?
3. Is it widely diffused throughout the earth?
4. Is it always injurious to land?
5. To what are crops growing in sandy land exposed?
6. How does it combine with manures?
7. Does sandy land require much work?
8. What is done to prevent the roots from being exposed?
9. Under what circumstances ought sandy lands to be converted into meadows?
10. What cereals can be cultivated on them?
11. What crops thrive best on them?
12. In what bodies is silica found?

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#### LESSON IV.

##### CLAY.

24. CLAY is composed of silica and another body called *alumine*, or *alumina*. This last, when obtained in a pure state, is a powder of a whitish color; it is distinguished by the facility with which it absorbs water.

25. Land in which clay predominates is not everywhere of the same color. It is often of a reddish hue; this is owing to the oxyde of iron it contains. If it contains a large proportion of humus, it becomes black, and loses its color by calcination.

26. Clayey soils have, as their distinguishing character,

the adhesiveness of their parts (due to the plastic property of the alumine they contain); and this property alone will enable even the inexperienced to discriminate them. A stiff clay when dried, by either natural or artificial heat, becomes so hard as to resist a considerable mechanical pressure. This property makes it valuable for the manufacture of bricks, tiles, pottery, etc.

27. On account of the tenacity of such soils, they are tilled with more difficulty than the freer soils. They require to fertilize them a larger proportion of manures; but they retain the effects of these manures a longer time. They are better suited to the cultivation of plants with fibrous than with fleshy roots, or tubers.

28. Soils of this class, as of every other, possess many degrees of natural fertility. The poor clays form, for the most part, an unprofitable soil; because, while their powers of production are inconsiderable, the expenses of tilling them are large. The clay soils of this character are generally of little depth, and rest upon a retentive subsoil. The natural herbage they produce is coarse, and not very nutritious; and they are not well suited to the cultivated grasses, and other herbage plants. They are little fitted for the growth of turnips, or other plants with fleshy roots or tubers. Such soils have everywhere local names, which sufficiently denote their qualities; and they are termed, by not an improper figure, *cold soils*.

29. Very different in their value and nature are the richer clays. These bear weighty crops of all the cultivated kinds of small grain; they do not excel the better soils of other classes so greatly in the production of corn and still less in that of barley, in which the lighter loams may surpass them. But they are unequalled in the production of wheat, and in many places derive their descriptive appellation from that circumstance, being termed *wheat soils*. They will yield large returns of the culti-

vated grasses and leguminous herbage plants, though they are not so quickly covered with the natural herbage plants of the soil, when laid down to perennial pasture, as the lighter soils.

30. Clays, like other soils, approach to their most perfect condition as they advance to that state which has been termed loam. The effect of judicious tillage, and of the application of manures, is to improve the texture of such soils, as well as to enrich them. Thus, clays in the neighborhood of cities become dark in their color, and less cohesive in their texture, from the mixture of animal and vegetable matter; and thence acquire the properties of the most valued soils of their class.

#### QUESTIONS.

1. What is the composition of clay?
2. What is alumine?
3. Why are clay soils sometimes red?
4. What is their distinguishing character?
5. What manufacture is clay valuable for, and why?
6. Are they as easily worked as other soils?
7. What is said about the application of manures to clays?
8. What class of plants succeed best in them?
9. Why are they unprofitable to cultivate?
10. They are unfitted for the growth of what plants?
11. Clay soils are unequalled, when of fine quality, for the production of what?
12. They yield large returns of what?
13. What is the effect of manures and judicious tillage upon their texture?
14. What is the effect of animal and vegetable manures upon their color?

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#### LESSON V.

##### CARBONATE OF LIME.

31. As we have indicated (No. 9), carbonate of lime is formed by carbonic acid and lime. Carbonic acid is a gas heavier than air; large quantities of it are thrown off by burning charcoal.

32. All earths that contain carbonate of lime are calcareous, and an excess is injurious, as the plants would tire. On the contrary, if the carbonate of lime is in suitable proportion, it is advantageous to the soil, and renders it better for cultivation.

33. Chalk, marble, limestone, shells, are calcareous. When exposed to the action of heat, the carbonic acid escapes, and they are converted into lime. Some of these substances, that become friable from the effects of frost, may improve the soil by increasing its depth.

34. Carbonate of lime is found almost pure in marble, but in other bodies it is often united with foreign substances. It can only be effective in the soil when reduced and pulverized by the action of heat. If it remained in its primitive state of stone, it would be more injurious than beneficial — impeding the plough, breaking implements, occasioning loss of time, and extensive repairs. This applies, however, to large stones only ; for if they are very small they improve clay lands, by rendering them less tenacious.

35. We know that lands containing clay in large quantities, are very compact, and difficult to cultivate. Carbonate of lime, reduced to an earthy texture, serves to loosen and render them more permeable to air, and to give them, consequently, properties favorable to vegetation.

36. There are also soils containing organic remains, that decompose with great difficulty, and from which, consequently, cultivated vegetables can derive but little benefit. Thus, with soils that have been a long time in fallow, and are clothed with fern, sedge, rushes, etc., if we content ourselves with merely turning them under, without the application of such substances as lime to favor their decomposition, a long time may elapse before the vegetation, so turned under, will produce the desired effect.

37. Sometimes even the substances contained in a soil

are totally inert and would so remain for centuries, without encouraging vegetation. Carbonate of lime possesses the property of decomposing all these remains, and of rendering them fit to serve the nutrition of plants. It also destroys the acidity of certain soils. We shall, however, have occasion to recur to the effect of mineral manures.

38. Certain plants seem to prefer calcareous to all other soils, as sainfoin and lucerne, both forage plants. The famous vineyards of Champagne are on a soil eminently calcareous.

39. Potatoes, turnips, beets, cabbages, Jerusalem artichokes, grow finely in calcareous soils; as do peas, corn, barley, tobacco, etc.

#### QUESTIONS.

1. What is the composition of carbonate of lime?
2. What is understood by calcareous earth?
3. What is the effect of too much carbonate of lime?
4. What is the effect when it exists in the right proportion?
5. What are the calcareous substances most commonly met with?
6. What occurs when carbonate of lime is exposed to the action of heat?
7. What is the effect of calcareous substances upon the soil when they are rendered friable by frost?
8. In what state must the carbonate of lime be to produce the proper effect?
9. What is the effect of carbonate of lime on clay soils?
10. On soils containing organic remains of difficult decomposition?
11. On acid soils?
12. What plants prefer calcareous soil?

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#### LESSON VI.

##### PLASTER, MARL, MAGNESIA, IRON.

40. AMONG the mineral substances that enter into the composition of soils, there are some of more rare occurrence, and in smaller quantity, than silica and clay.

These are plaster, marl, magnesia, iron, and manganese.\*

41. Plaster, or gypsum,† is of importance not only as a constituent part of certain soils, but also on account of the effect that it produces upon certain plants, to the growth of which it is particularly favorable. It is diffused throughout nature to some extent, and in some localities it is quarried in large quantities. After being pulverized, it is used either in building, or as an agent of vegetation. There is this difference between carbonate and sulphate of lime: when exposed to heat, the first loses its acid; whereas the second, as it never separates from its sulphuric acid, ever remains in the state of a salt.

42. Marls are found in many soils, and sometimes in such quantities as to make them unfruitful. They are of different colors—white, gray, blue, etc. Their elements are generally clay and carbonate of lime, often mixed with silica, or shells that also contain carbonate of lime. Marl is said to be more or less rich as it contains more or less carbonate of lime.

43. Marls, as we shall see hereafter, are very useful in the amelioration of lands. They are distinguished from other earths by the effervescence produced when they are brought in contact with acids. This property is common to all substances containing calcareous principles.

44. Magnesia, which in a pure state is a white, insoluble substance, is generally found in the soil in the state of a carbonate—that is to say, united with carbonic acid. Some writers pretend that this body, if employed without being calcined, is injurious to vegetation; but this is not

\* This last, as well as some other earthy bodies, are met with so rarely, and in such inconsiderable quantities, that we will make no further allusion to them.

† Frequently called gypsum: it is composed of sulphuric acid, lime, and water.

confirmed by facts. It is probable that carbonate of magnesia acts upon the soil like carbonated lime.

45. Iron is found in the soil in the state of an oxyde; that is to say, united with oxygen. It is sometimes, also, met with as a carbonate. It rarely exists in large quantity in the arable soil; if it existed in proportions rather strong, it would render the last entirely barren.

46. Iron, through its property of coloring soils, causes them to absorb more heat; for it is well known that white substances are not so readily warmed by the solar rays as black ones.

47. Iron is more or less injurious according to the degree of oxydation. When it does not contain the whole of the oxygen with which it is capable of combining, it injures vegetation.

#### QUESTIONS.

1. What substances besides silica and clay are sometimes to be met with in the soil?
2. Is plaster of importance to agriculture?
3. Is it generally disseminated throughout nature?
4. Of what is marl composed?
5. Which are the richest marls?
6. To what use are they put?
7. How do we detect the presence of calcareous principles in a soil?
8. What is magnesia?
9. In what state is iron found in the soil?
10. Is a ferruginous soil fertile?
11. How can iron render the earth warmer?

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### LESSON VII.

#### THE ORGANIC PARTS OF THE SOIL.

48. THAT a soil should be productive, it is not alone sufficient that it should contain, in suitable proportions, the mineral substances that we have studied in the pre-

ceding lessons ; but it must also, united with the mineral elements, contain elements of organic origin ; for these last play a very active part in vegetation.

49. If we examine closely what passes in nature, we will perceive that all organized bodies are continually changing in shape, until finally, the vital principle ceasing to exist in them, they perish and decompose. It is these decomposed bodies that we put on the land to satisfy the wants of plants, which, after having served as food to man and animals, become the source of a new vegetation.

50. This alternate and continual change has caused it to be said that vegetation is the source of reproduction, and in truth : "No plants, no animals ; no animals, no manure ; no manure, no cultivation." As we perceive, bodies are not annihilated ; they are only continually assuming different forms. The earth may be considered as a mediator between life and death, as it receives from disorganized vegetable elements that it gives back to a new organic life.

51. A soil is the richer, and consequently the more productive, as it contains more organic remains. On the other hand, as we have some crops that are more exacting than others as regards the quantity of nutritive elements that they require, it follows, that the farmer should take the least exhausting crops from the least fertile land ; for in rational agriculture we can never exact from a soil more than we give it, or more than its nature permits it to furnish.

52. The soil is not always exhausted by the crops that it yields ; for such crops leave remains that decompose in the soil. These remains are the leaves, stems, and roots of the plant. The more numerous they are, the less is the soil injured ; and it may be (as with clover), that it has lost none of its value ; so that, to obtain other products, it is not necessary to add to the organic remains already within it. But the farmer ought, in this case, to be

thoroughly acquainted with the exhausting power of the plants that he cultivates, so as not to exact from the land more than it can yield. We shall return to this subject hereafter.

53. All organic bodies are not composed alike, nor are they of equal value as manures. They may be derived from vegetables or animals. Those of vegetable origin are formed for the most part of oxygen, hydrogen, and carbon.\* There are a few vegetables, such as the cabbage and rape, that contain azote.† Animal remains, on the contrary, all contain azote, united to the three other bodies; and for this reason they are more nourishing, more active, but less durable, than vegetable substances, because they are decomposed more rapidly.

54. All organized bodies are not decomposed with equal rapidity. In the vegetable, as in the animal kingdom, there are some that remain a long time in the soil, without producing the least effect. Different means are employed to render them suitable to the wants of vegetation, as we shall see in the following lesson, treating of humus.

#### QUESTIONS.

1. What must be done to make a soil productive?
2. Do organic bodies always retain the same form?
3. Is vegetation the source of reproduction?
4. What is it that renders the soil rich and productive?
5. What vegetables ought to be cultivated upon a poor soil?
6. What are the remains that certain vegetables leave in the soil?
7. Do all plants exhaust the soil?
8. Are all organized bodies formed of the same elements?
9. Of what elements are vegetables formed?
10. What elements form animals?
11. Do all organic remains decompose with equal rapidity?

\* Hydrogen and carbon are two bodies very generally disseminated throughout nature. Hydrogen united with oxygen forms water. Carbon is nothing more than pure charcoal. Plants assimilate to themselves a greater quantity of this substance than of any other.

† Azote is a body which, united with oxygen, forms the air that we breathe.

## LESSON VIII.

## THE FORMATION OF HUMUS, AND ITS PROPERTIES.

55. HUMUS results from the decomposition of organic bodies (see No. 8). The proportion and nature of its constituent elements are not always the same; for in some cases animal, in others vegetable parts predominate.

56. Straw, and the excrements of cattle, are destined to be transformed into humus. As this substance is of an earthy texture, gardeners give it the name of *mould*. This last denomination, however, has also been given to the manure derived from the cleaning of ditches and the sweepings of streets, that have been exposed for a time, in heaps, to the action of the atmosphere.

57. Among the bodies forming humus, some are decomposed in the open air, others in the bosom of the earth, and others in wet and marshy places, according to the circumstances in which they may have happened to be placed. In the latter case, *turf* is often formed. This proceeds from the decomposition of vegetables that have grown successively, for a long time, upon the remains of plants similar to themselves.

58. Turf, or peaty lands, are recognised by their elasticity, their porosity,\* and their blackish color. Turf is employed as fuel, and as manure. Turf formed under the water is devoid of any acid principle; but that on the surface of the soil is often acid.

59. The properties of humus vary according to the

\* Elasticity and porosity are properties possessed by all bodies in a greater or less degree. When a body submitted to pressure bends out, and resumes its first shape after the pressure is taken off, it is said to be elastic. A sponge, for instance, is elastic. Porosity is a property possessed by bodies of being filled with holes, of a greater or less size, and more or less numerous. Thus, the human skin is very porous, as a square inch of it is pierced with many thousand holes.

bodies that it is derived from. That from fecal matters (poudrette) is more active than that derived from the excrements of animals. It is pretended that humus accruing from horses and birds produces a better effect on the soil than that from cattle. It is admitted that the excrements of pigeons and poultry are much more active, in similar quantities, than manures derived from other animals. We should not, however, as we shall see hereafter, attach too much importance to these distinctions in the value of the manures in more general use.

60. Matters derived from animals, entering easily into putrefaction, furnish a humus of better quality than that proceeding from vegetable matter ; for these are often decomposed with great difficulty.

61. Humus is sometimes acid, particularly in low and wet places, such as turf is formed in. When it has this property, it is injurious to vegetation. In this case, to render it fit food for plants, calcareous substances, such as lime, are put in the soil ; and they are in this instance a very efficient remedy. Moreover, in lands that contain carbonate of lime, sour humus is never found. Animal black may be substituted for carbonate of lime ; it is a substance derived from the calcination of bones.

62. *Paring and burning*, also, destroy the acidity of the soil. It consists in paring off the crust of the earth, some two or three inches deep, burning it in small hillocks, and in scattering the ashes. This operation has also the advantage of destroying noxious weeds and insects.

#### QUESTIONS.

1. What is humus ?
2. Is it always composed of the same elements ?
3. By what other name is it called ?
4. Where are the bodies decomposed that form humus ?
5. Where is turf found ?
6. By what are turf lands recognised ?
7. What use is made of turf ?

8. In what circumstances is turf sour?
9. What distinction is drawn in the value of humus?
10. Which is the best humus, that derived from animal or that from vegetable matters?
11. In which case is humus sour?
12. What means are employed to correct the acidity in humus?
13. In what does paring and burning consist?
14. What other advantage does this mode possess?

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## LESSON IX.

### OF THE ACTION OF HUMUS IN THE SOIL.

63. Organic remains that are decomposed in the soil produce two different effects: 1. They furnish the plants with a part of their nutritive principles. 2. They act upon the physical properties of the soil.

64. The properties of the soil are divided into two classes. Those that relate to its composition take the name of chemical properties; and those that concern its texture, its position, etc., are called physical properties.

65. The action of humus, as food for plants, has been very much discussed by modern writers. Some contend that humus, by means of the carbon that it contains, furnishes the roots with the greater part of the elements necessary to the vegetation of the plant; and that a feeble portion only of these elements is derived from the atmosphere. Others, on the contrary, have maintained that the atmosphere supplies the greater part of the nutritive elements, because the hydrogen, oxygen, and carbon, that enter into the composition of all vegetables, are furnished by air and water, and are consequently derived from the atmosphere.

66. This last opinion is in truth supported by some facts. Thus, we have some very productive lands containing very little humus. Some vegetables, supplied with water only,

and exposed to the influence of the air, have attained a fine development. But these are altogether exceptional cases ; and it must always be admitted as a general rule, that a soil yields fine crops only when it contains a supply of humus in proportion to the wants of the plants. Moreover, that a vegetable should be able to derive its food from the atmosphere, it must already have grown out of the earth ; and it must consequently have received from the soil sufficient strength to perform this act.

67. It is known that a good deal of carbon enters into the composition of all plants ; but they do not absorb this substance in the state in which it is found in their organization. It can only be absorbed by the roots and leaves in the form of gas, and united with oxygen that is in the state of carbonic acid. Plants exposed to the influence of the sun lose their oxygen, and the carbon combines with the other elements to furnish that infinite variety of products that vegetation displays.

68. As to the physical properties of humus, it loosens the compact, and give consistency to light soils. By its color it imparts coolness to a dry soil, and can in other cases give warmth to the land. It renders stiff soils permeable to air and other atmospheric influences, and permits the roots of plants to penetrate the arable surface with greater ease.

69. In light land that is hot and burning, humus is decomposed with great rapidity, so that it requires but a slight quantity to produce an immediate effect ; but in return these soils are soon exhausted. Calcareous soils also decompose humus with great facility, and for this reason such lands should be manured with substances of difficult decomposition ; for in a stiff soil they would remain inert for very many years.

## QUESTIONS.

1. In how many ways does humus act upon the soil ?
2. How are the properties of the soil divided ?
3. What are the different opinions on the action of humus in the act of vegetation ?
4. Are there facts that sustain one or the other of these opinions ?
5. Can these facts establish a general rule ?
6. In what state is carbon found when absorbed by plants ?
7. What is the action of humus on the physical properties of soil ?
8. In what soils is humus most readily decomposed ?
9. What substances ought in preference to be placed in calcareous soils ?
10. What would they do in stiff soils ?

## CHAPTER II.

*The Physical Properties of Soil.*

## LESSON X.

## TEXTURE AND DEPTH OF THE SOIL.

70. ~~The~~ nature and the proportion of the elements that compose a soil are not the only causes that influence its quality or degree of fertility. The physical properties (see No. 65) exert also an influence that it is very important that the farmer should know. There may be a considerable difference in the value of two fields, even when they are composed of elements of the same nature, and are in the same neighborhood. This difference is due to several causes, that we will now examine.

71. The first thing that a farmer should attend to, who wishes to lease or rent a farm, is the texture and depth of the soil. These are two properties that should have the greatest influence, not only upon his choice of rotations,\* but upon the cost of cultivation. Of two farms of equal extent, one may cost twice as much to cultivate as the other. We may easily conceive, then, how important it is that the farmer should possess a thorough knowledge of the properties to which we allude.

72. The texture or consistency of a soil is nothing more than the degree of strength with which its molecules are bound to each other; this is what is called cohesion. The more consistent a soil is, the harder it is to work, and the

\* A system of rotation is that by which, on a given piece of land, one crop is made systematically to follow another.

more impenetrable to the roots of plants. A medium consistency agrees best with vegetation. This may be obtained by hauling upon the land a quantity of humus; but as this method would be too costly, particular substances are made use of (that we shall describe hereafter), called ameliorators (mineral manures).

73. If too close a texture is injurious to vegetation, too loose a one is not less so, and very sandy land is of little or no value. In a blowing sand, plants can not take the fixity that they require, and are forced to fall.

74. All soils are not of equal depth; they vary from half an inch to many feet.

75. Deep soils possess over others important advantages. They retain moisture better in seasons of drought, without becoming too wet in rainy weather. When equally rich, they furnish plants with a greater mass of food than other soils. Long-rooted plants, such as lucerne, and tap-rooted plants,\* such as beets, parsnips, carrots, etc., thrive best in soils of great depth.

#### QUESTIONS.

1. Are the physical properties of the soil of any consequence to the cultivator?
2. What ought first to be looked to by a farmer wishing to lease or purchase a farm?
3. Why should we seek to know the texture and depth of a soil?
4. What is meant by the consistence of a soil?
5. What are the defects of too much closeness?
6. What is the best consistence?
7. Will humus bring it about?
8. What are the inconveniences of sandy soils?
9. Are all soils of the same depth?
10. What advantages do deep soils possess over others?
11. Which are the plants that thrive best in a deep soil?

\* Tap-roots are those that descend perpendicularly, to a certain depth, in the soil.

## LESSON XI.

## SITUATION OF THE SURFACE.

76. WHETHER the surface of a farm lies well or not, depends upon the nature of the soil. Thus, sandy land rarely suffers from being level, as it seldom retains too much moisture. Clayey lands, on the other hand, being naturally disposed to moisture, would evidently suffer from continued rains, if so situated. The water not being able to penetrate through the earth, would remain upon the surface, and injure and sometimes kill the plants.

77. Arable lands lie best when just sufficiently rolling to carry off the surplus water, with the assistance of the water-furrows that should always be made immediately after seeding. Water-furrows are of great importance, and farmers are frequently great losers by neglecting to make them; for wheat covered by water, in freezing weather, often suffers, and is frequently killed.

78. In some cases, water-furrows do not remedy the evil of too much moisture. Recourse is then had to ditching, or what is better, under-draining, which is done by digging narrow ditches, filling them half full with broken stone or brush, and then throwing the earth back into them. The water, when the operation is properly performed, will flow freely among the stones or brush, at the bottom of the ditch.

79. Some farmers have even changed the nature of the subsoil, by replacing it with stone and gravel; but this process is enormously expensive, and only applicable on a very small scale.

80. Hilly lands possess some advantages over those that are level; among others, the better exposition of the plants to light and air.

81. But these advantages are overbalanced by serious

drawbacks ; heavy rains carry off the soil and manures ; the ploughing is more difficult, and the hauling heavier.

#### QUESTIONS.

1. What indicates the best situation that a soil should be in ?
2. May sandy lands be level ?
3. Is it as well that clay lands should be level ?
4. How do clay lands lie best ?
5. What precautions should the farmer take to preserve his lands from too much moisture ?
6. When should we under-drain ?
7. What other means can be employed to carry off the water ?
8. What advantages do hilly lands possess ?
9. What are the objections to these lands ?

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### LESSON XII.

#### SUB-SOIL.

82. THE elements of the sub-soil are sometimes of the same nature as those that compose the surface ; but they have not the same properties, for they are deprived of contact with the air, and are rarely found mixed with mould. In other cases, the mineralogical elements of the sub-soil are of a nature entirely different from those on the surface.

83. We may in general distinguish three species of sub-soil ; the clayey, the sandy or gravelly, and the calcareous. Depending upon the nature of the soil, each of these sub-soils, as we shall see, endows it with properties more or less favorable.

84. A clayey sub-soil, beneath a clay soil, is injurious, as it retains too much moisture in wet weather, and becomes too hard in seasons of drought. This evil is somewhat corrected by deep ploughing, which loosens the soil, rendering it more permeable, and capable of retaining a greater quantity of water, without being injurious to vegetation.

85. If a sandy soil covers a clay sub-soil, it is much less exposed to the evil effects of drought, on account of the moisture retained beneath it; and by deep ploughing the clay may be mixed with and thus improve it.

86. These mixtures of the sub-soil and soil are not the only means that the farmer possesses of preserving in the land the moisture necessary to the vegetation of plants. Frequent working gives also to land the property of retaining moisture, and this is the case as well with a stiff as with a sandy soil. The cause of this has not yet been well explained, but it is so; and it is in contradiction to an opinion entertained by many, that frequent working in times of drought is injurious to the crop.

87. As a clay sub-soil is suitable to sandy land, just so is a sandy sub-soil favorable to a surface containing much clay. It permits the infiltration of the superabundant moisture, and may ameliorate the soil if mixed with it.

88. But a sandy soil, based upon a sub-soil of the same nature, being entirely too permeable to moisture, must suffer much from drought, and yield but indifferent crops. There is too great waste of manures, as their liquid parts sink too deep.

89. When the soil is devoid of carbonate of lime, and the subsoil is calcareous, a mixture of the two by deep ploughing is evidently beneficial. Stiff soils particularly will profit by this mixture; for at the same time they will lose a portion of their tenacity, become more favorable to vegetation, and rendered easier to work. But the carbonate of lime in the sub-soil must be in an earthy state, and not in the form of stones, a few only of which, the schistous, can, as we have seen, become friable on the surface.

90. From what precedes, we perceive that there are many cases in which deep ploughing can improve the soil, and increase its products. It is true that, in certain cases, these workings appear in the first years to injure rather

than benefit the soil. This is the case when the sub-soil contains principles, such as the oxyde of iron, that may be fatal to vegetation. But generally in a few years these injurious properties disappear, after the elements brought to the surface have been acted upon by atmospheric influences, and mixed with humus.

91. The farmer sometimes contents himself (and perhaps it is the best plan) with merely stirring the sub-soil, without bringing it to the surface. It is then acted upon by the atmosphere, and gradually mixed with fertilizing influences. This operation is performed by a plough made for the purpose, called a sub-soil plough, which follows in the furrow immediately behind the ordinary plough.

#### QUESTIONS.

1. Are the mineralogical elements of the soil and sub-soil of the same nature?
2. How many kinds of sub-soil are there?
3. Is a clay sub-soil favorable to a clay soil?
4. What is the remedy for too much moisture in a clay soil?
5. Is a sandy soil favored by a clay sub-soil?
6. Do frequent workings preserve moisture in the soil?
7. Is a sandy sub-soil favorable to a clay soil?
8. When the soil and sub-soil are both sandy, is it favorable?
9. Can a calcareous sub-soil improve the surface?
10. Which soils are most benefited by mixture with carbonate of lime?
11. In what state should the carbonate of lime be to produce an effect upon the soil?
12. In what circumstances would deep ploughing be disadvantageous?
13. How is the soil deepened without bringing the sub-soil to the surface?

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#### LESSON XIII.

##### THE EFFECT OF CLIMATE ON VEGETATION.

92. THE temperature requires great attention on the part of the cultivator; for it is well known what influence it exercises on vegetation, and that it varies according to

localities. In the northern states the cold is generally intense, and lasts a long time; whereas in the southern heat predominates. There are also countries that, by their position, are much damper than others, or which are more exposed to storms, hail, etc. It is to the aggregate of all these atmospheric circumstances, that we give the name of climate.

93. We may adopt three climates; the northern, the southern, and the mean, or intermediate. But these three climates may be subdivided to infinity; and it may almost be said, that each state, county, town, and village, possesses a particular climate of its own; for it is not a rare circumstance to see two neighboring places differ greatly in this respect.

94. The position of a district or place influences its climate greatly. There are places that enjoy a low (cold) temperature though beneath the equator. This comes from their position, which is much more elevated than the level of the ocean. This is partly the reason why the cold is always greater on the summit of high mountains than at their base; and it is also one of the reasons why very high mountains, though in southern countries, are always covered with ice and snow.

95. Each plant has not only a soil, the properties of which suit it better than those of any other, but it has also a climate appropriated to its nature. Moreover, the species of cultivated plants are in many cases as different as the temperature of the place in which they are found is more or less elevated (warm). Thus it is that in the south the cotton-plant, the sugar-cane, and the fig, flourish; whereas, if these vegetables were transplanted to the north, they would perish from cold.

96. Crops ripen much more rapidly upon a warm than upon a cold soil; so in southern climates vegetation is much more rapid than at the north.

97. Vegetation in general suffers from intense cold, but more particularly that of certain plants. But what does the most injury, in these cases, are the sudden changes in temperature; and the damage is greater to plants growing upon light soils. Whenever the temperature falls gradually, vegetation suffers but little. It is for this reason that a frozen plant should never be put in a warm place. To restore its vigor, we should give it a temperature that will cause it to thaw insensibly.

98. It is particularly after great moisture that plants suffer when overtaken by frost; for in this case the stem is more tender and watery. The water and sap, that are increased in volume by congelation, then burst the tissues of the plant, and destroy the vital principle of certain indispensable organs.

#### QUESTIONS.

1. What is the climate of a country?
2. What are the principal climates?
3. Are there others?
4. Does the position of a place influence its climate?
5. Can the same plants be cultivated in places of different temperature?
6. In which climate is vegetation most rapid?
7. Is vegetation injured by cold?
8. When is a change of temperature most hurtful?
9. How must we proceed to thaw a plant?
10. In what circumstances do plants suffer most from cold?

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#### LESSON XIV.

##### THE EFFECT OF CLIMATE UPON CULTIVATION AND UPON ANIMAL ECONOMY.

99. IN the preceding lesson, we indicated the causes upon which the state of a climate depends, and its general effects upon vegetation. We have yet to consider it under

another aspect ; its influence on the cultivable properties of the soil, and the rearing of domestic animals.

100. A vegetable transplanted from one soil to another, does not at first grow with its original vigor. So is it in this case with men and animals. A sudden change of diet deranges for some time the animal organization ; and a transition even somewhat protracted is always necessary. Plants require to be gradually accustomed to the new circumstances in which they are to grow ; and often, when removed to a new climate, their conformation is changed, and their products, in both nature and quantity.

101. The study of climate is above all necessary when the object is to change, in any locality, the system of agriculture that has been for a long time prevailing there. In this case some trials should be made to ascertain whether the plant desired to be introduced into the rotation will succeed. The same precautions should be taken with the animals to be employed in agricultural labor.

102. In a damp climate, the defects of the lighter soils are less to be feared, as they are then less exposed to drought. The dampness of climate, however, does not depend so much upon the quantity of water that falls as upon the heat, more or less great, that causes it to evaporate. But it is well known that one country may possess a dryer climate than another, though more rain may fall in the first than in the second.

103. The Creator, who placed and arranged everything here in such admirable order, adapted also to man's wants all the plants that grow in the climate that he inhabits. In England, for instance, the climate, though damp in consequence of its vicinity to the ocean, is more regular than with us. Under such a climate succulent food is very necessary ; accordingly nature favors, to a remarkable degree, the development of such plants as are necessary to the maintenance of numerous herds,

104. In the south, where the heat is greater, nature produces fruits, and other refreshing aliments, so necessary to man in warm climates. Animals too can be maintained differently from those in the north ; for there the temperature permits them to pass the whole year in the open air. In the United States, between Maine and Florida, we have almost every variety of climate ; consequently, in the way of agricultural products, the nation is singularly rich.

#### QUESTIONS.

1. Does a vegetable transplanted from one climate to another grow off at once ?
2. In what instance is the study of climate particularly necessary ?
3. Do the lighter soils suffer much in damp climates ?
4. Are the productions of the different climates adapted to the peculiar wants of the inhabitants of those climates ?
5. What is the condition of the United States in regard to climate ?
6. What is their condition in regard to productions ?

## PART THIRD.

## CHAPTER I.

*Ameliorators.*

## LESSON I.

## GENERAL VIEWS OF MANURES, AMELIORATORS, AND STIMULANTS.

1. Most of the products of the earth serve as food for men and animals. Among the latter, some furnish us with the necessary power to work the earth; others give us milk, cheese, wool, meat, etc. But that animals may continue to furnish us with these, the necessities of life, they should be well cared for, and supplied with an abundance of healthy and nourishing food.

2. So is it with the earth. She never refuses us her gifts if she is well cared for, and her strength renewed, after furnishing food to exhausting crops.

3. All cultivated vegetables do not exhaust the soil to the same degree. The farmer should study carefully the properties of plants in this respect; for it is the only way to establish a judicious and profitable system of rotation. Thus, after a crop of clover, the land requires no manure; for it receives from this crop more than it gives; and it may grow another crop more or less exhausting, depending upon its previous condition.

4. That a soil should be productive, it must contain the mineralogical elements in suitable proportions. Each one of the simple bodies (silica, clay, lime, etc.) that we have described, is sterile in itself; it is only by their mixture that they can give the soil the qualities suited to vegetation.

5. If Nature has not always effected these mixtures in just proportions (and this is one reason of the difference in the value of land), she furnishes us, in return, the means of amelioration, that enable the farmer to supply this defect. It is precisely because the use of fertilizing means is neglected, that we see everywhere so much waste land.

6. The soil requires two species of elements that it is important not to compound. Some accrue from organic bodies, and are called *manures*; their principal object is to serve as food for plants. The others are the produce, for the most part, of the mineral kingdom, and take the name of *ameliorators*; they give the earth advantageous properties relative to cultivation, by improving its texture when either too stiff or too loose.

7. There are also other substances, such as plaster, which in most cases, without modifying the composition of the soil, give activity to the vegetation of plants, by forcing them to absorb more nourishment from the soil and atmosphere. These bodies are called *stimulants*.

8. The same substance may perform more than one function; it may serve at the same time as a manure and as an ameliorator. Dung, for instance, as we shall see hereafter, applied to certain soils, may at the same time furnish food to plants and force into action certain inert principles contained in the soil.

9. It is of the utmost importance to the success of the farmer, that he should give his attention to soils that are deficient in their composition; but above all things he should be acquainted with the mode of action, and the

manner of employing substances that are so necessary to the amelioration of his land. This knowledge must guide him both in his choice of ameliorations and in the manner of their execution. It is for this reason that, after the study of soils, we introduce that of ameliorators, the employment of which, in many cases, is indispensable.

#### QUESTIONS.

1. Do animals furnish products useful to man ?
2. What must be done to enable them to continue the supply ?
3. What must be done for the earth to enable it to continue its supplies ?
4. Are all plants equally exhausting ?
5. What must the farmer do in this respect ?
6. What is necessary that a soil should be productive ?
7. Are simple bodies always mixed in suitable proportions ?
8. Why are there so many waste lands ?
9. Which are the two species of elements required by the soil ?
10. What are stimulants ?
11. Can the same substances act in more ways than one on the soil ?
12. To proceed properly in the amelioration of soils, what knowledge should the farmer possess ?

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#### LESSON II.

##### LIMING LANDS, OR THE USE OF LIME AS AN AMELIORATOR.

10. LIME, as we have seen, is a compound of oxygen and a simple body called calcium. To obtain it, carbonate of lime must be submitted to the action of heat until calcined. The water of crystallization escapes in the form of vapor, and the result is quick or caustic lime.

11. Besides the use that is made of lime in building, it is also employed as an ameliorator in those localities in which agriculture is in a state of improvement; and if farmers have not often recourse to this means of increasing the value of their lands, it is because they are generally ignorant of the good effects it produces, or because

they do not know in what circumstances liming can be advantageously effected.

12. To use lime as an ameliorating substance, it is necessary that the farmer should know how to distinguish the soils that would be improved by the application of calcareous ameliorators. In effect, it is useless to add humus to land containing already enough ; just so is it useless to add lime to land that has enough. It would be a useless waste of labor, and might produce injurious consequences.

13. The carbonate of lime, then, as an ameliorator, is only suited to such lands as do not contain calcareous principles. It is easy to recognise them : whenever an earth, brought in contact with an acid, produces an effervescence, we may be certain that it contains a sufficiency of lime to produce the desired effect upon such organic parts of difficult decomposition as may be contained in the soil.

14. The spontaneous vegetation, also, frequently indicates the lands upon which lime may be used to advantage. Thus, those lands upon which broom, red sheep-sorrel, heath, the chestnut, and resinous trees, grow spontaneously, are generally disposed to increase in value by the application of lime.

#### QUESTIONS.

1. What is the composition of lime ?
2. How is it obtained ?
3. What use is it put to ?
4. Why is not its use more general in agriculture ?
5. What ought the cultivator to know to make use of lime ?
6. Are calcareous soils improved by liming ?
7. How are calcareous soils recognised ?
8. By what sign do we recognise the utility of liming a soil ?

## LESSON III.

## LINING LANDS (CONTINUED).

15. WE have seen that, as an ameliorator, lime is not suitable to calcareous soils; but we are not thereby to understand that it is to be employed with advantage on every other kind of soil. It has been remarked, on the contrary, that on certain soils, lime has produced no effect whatever, without its being possible to discover in their composition any explanation of the fact.

16. We may then conclude that soils, independent of their composition, are more or less disposed to improvement by calcareous ameliorators. Trials should be made in this respect; and this means of amelioration, where it can be employed, should never be neglected.

17. Lime has frequently been employed with disadvantage, because it was looked upon as a manure. If organic remains are found in the soil, in tolerable quantities, we may certainly obtain by means of lime alone tolerably fair crops, for two or three years in succession; but after this time we will have an exhausted soil, that will return with great difficulty to a productive state. By liming without manuring, we would give the soil a factitious activity, that would be followed by sterility.

18. We ought then to consider the liming of land as a means of preparing the food of plants, and of putting in action inert principles that otherwise would have remained dormant and unproductive; but we must not think that lime itself is a principle of nourishment. Perhaps, as is supposed by a distinguished German author,\* liming may also supply the roots with a quantity of carbonic acid, in addition to that furnished them by the humus.

\* See Von Thaer, in the "Farmers' Library and Monthly Journal of Agriculture."

19. It is wrong to pretend, as some do, that the effect of lime is different as it happens to be in the state of carbonate or that of quick-lime. Facts prove the contrary, and theory agrees with them. In effect, lime, when it comes from the kiln where it is quick, is deprived of its carbonic acid; but it recovers it very soon when placed in the soil, by taking possession of that which it finds there, or by drawing it from the atmosphere. Thus, whether we place the caustic lime or the carbonate of lime in the earth, it must in the end be carbonate of lime that produces the effect. Only lime deprived of its carbonic acid, may be employed in rather smaller quantity.

20. We repeat, to fix the attention upon the utility of lime, that the farmer ought by all means to make a trial of it on a small scale, upon the different species of soil that he cultivates. He may be guided by the result of these experiments. Without this precaution, he would run the risk of losses, often heavy.

#### QUESTIONS.

1. Does lime produce an effect on all soils that are not calcareous?
2. What ought to be done to ascertain if a soil should be limed?
3. What is the error that has often caused liming to be abandoned?
4. What is the effect of lime without manure?
5. How ought we to consider the liming of land?
6. Is there a difference in the effect of carbonated and caustic lime?
7. What should the farmer do to decide about liming?

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#### LESSON IV.

##### LIMING LANDS (CONTINUED).

21. WE have seen that lime gives activity to vegetation, by the property which it possesses of decomposing humus, and rendering it sooner fit to serve as food to plants. It

also destroys the acid principles in the land ; but this must not be in a low, wet state, or it must first be drained.

22. Moreover, lime, when it acts, according to the opinion of some writers, gives additional strength to the straw of the different cereals, and thereby prevents them from falling or lodging. It corrects the defects of soils that are too cold and wet, and increases the porosity of those that are too stiff. It consequently influences, in a sensible degree, the yield of crops.

23. We have seen (No. 19) that the effect of carbonate of lime does not differ from that produced by quick-lime ; this last, however, should be preferred, and for this reason : Calcareous substances, to produce all the effects to be expected from them, should be in an earthy state. It is then necessary that the carbonate, before being employed, should be pulverized, or reduced to powder ; this is easily done by calcination. To pulverize it in any other way would be tedious and expensive.

24. When we are assured that a soil contains no calcareous substances, the next thing to be ascertained is the quantity of lime to be employed, and the time and manner of applying it. Here are some rules to be followed in this respect.

25. The quantity of lime to be used depends, in general—  
1. On the durability desired to be given to the amelioration. 2. The nature of the soil to be limed. 3. The nature of the lime that is used. It is by the examination of these three causes that we can ascertain the quantity of lime necessary to be applied. It is, however, understood that clay soils, particularly those that are cold turf-lands, and the soils in which organic remains do not readily decompose, require heavier liming than light and sandy soils. On the last, not more than half as much is used as in the first.

26. Lime may be applied to the land in different ways, and at different periods. 1. It may be laid on the surface

of mowing or pasture land, and remain there until it is ploughed up for tillage, even though this should be several years afterward. The lime in this case quickly sinks into the soil, and, acting upon it, prepares it for crops when it is again tilled. 2. It may be spread upon the ground, and covered by the plough, just after a crop of any kind has been gathered. In this case, it prepares the soil for the succeeding crops. 3. It may be spread upon the surface even when plants are growing. This practice, however, though sometimes convenient, is rarely to be imitated. 4. It may be and is most frequently applied during the season when the land is in fallow, or in preparation for what are termed fallow crops.

27. That lime may produce an immediate effect, it must be thoroughly mixed with the soil ; and this is why it is generally put upon a fallow, a year or more before it is broken up. There is a very simple machine now in use, called a lime-spreader, that is attached to the tail of an ordinary cart, which spreads the lime very evenly.

28. The effect of lime is sometimes not perceptible until the second or third year ; this is when the mixture with the soil has not been properly effected. It is very important that land should be well drained before being limed, because lime improves only such as are moist by nature, and not by position.

#### QUESTIONS.

1. What is the action of lime upon land ?
2. What are the other effects ?
3. Why prefer quick-lime to carbonate of lime ?
4. Before liming, what is it necessary to know ?
5. On what generally depends the quantity of lime to be employed ?
6. Which soils require the most lime ?
7. In what quantities is it applied ?
8. How is the spreading best effected ?
9. What should be done to enable lime to produce an immediate effect ?
10. Is a soil in a wet situation improved by liming ?

## LESSON V.

## MARL AS AN AMELIORATOR.

29. WE have seen (No. 42, second part), that marl is a compound of carbonate of lime mixed with clay, silica, shells, and other inorganic substances, in various proportions. The quantity of calcareous principles that a marl contains has a direct influence upon its use as an ameliorator, and for this reason it has been thought useful to distinguish several kinds of marl, that each suit soils of a different nature.

30. The principal kinds of marl are : 1. The calcareous ; those containing the most carbonate of lime, and which are consequently the richest. 2. Marl properly so called, that does not contain more than half its weight in calcareous substances. 3. Clayey marl, that contains three or four times as much clay as marl. 4. Marly clay, that contains the feeblest portion of calcareous carbonate.\*

31. Marl can not always be recognised simply by the eye ; to distinguish it, it is necessary to have recourse to the means indicated in treating of the mineral parts of the soil.

32. The same error that prevents the use of lime also prevents that of marl, in many instances, when it should be used. It has been often used as a manure, when it should merely be considered an ameliorator. Whenever lime or marl is used upon a soil deficient in the proper quantity of organic remains, so far from producing any effect upon the physical properties of the soil, it will be apt to injure by giving it too much activity.

33. Marl, by its beneficent properties, should play an important part in the agriculture of many districts in the

\* There are many other varieties not necessary to describe.

United States, particularly along the seaboard, and in the southwestern states, where it abounds in vast beds of the finest quality. In New Jersey, Delaware, Maryland, and Virginia, exhausted and wornout lands have been brought to the highest state of productiveness by abundant marling. Its great abundance and richness, in the now wornout lands along the tidewater of the old southern states, will yet make them rival the virgin fertility of the western states, and perhaps give the tide of emigration a new direction. Like lime, it improves alike the texture of sandy and stiff lands, and it has the advantage of lime in being generally cheaper.

34. Before using marl as an ameliorator, we should know how to discover whether a soil contains carbonate of lime; and we should be able also to determine the quantity of this substance. To make this experiment (and there is no sort of difficulty about it), a portion of the soil to be tried is taken at a certain depth, and not on the immediate surface; for this last might, independent of its primitive composition, contain calcareous substances, placed there at some period more or less remote.

35. The following is the very simple process by which the proportion of calcareous matter contained in marl is determined. Take a set of delicate scales, and after drying, without hardening, one hundred grains of the earth to be tried, they are put in a vessel, and a sufficiency of water to crumble it to an earthy consistence is added. Upon this a few drops of nitric acid are thrown, and the mixture is worked up with a wooden spatula; effervescence immediately takes place; and the carbonic acid escapes. This last is replaced by the nitric acid, which then forms a nitrate of lime. As this body has the property of remaining suspended in water, it is expelled by several successive washings; taking always great care that the other earthy particles are precipitated to the bottom of the

vessel. After this, the residuum is nothing more than clay and silica, the weight of which is easily ascertained by the scales. If we then compare it with the original quantity operated on (that is, the hundred grains), the difference will be the exact quantity of carbonate of lime contained in the marl; for the diminution is occasioned by the escape of the carbonic acid gas, besides the lime that was expelled with the nitric acid.

#### QUESTIONS.

1. Why do we distinguish several kinds of marl?
2. Which are the principal kinds of marl?
3. Can we distinguish marl simply by the eye?
4. Why has so little marl been employed?
5. What is the effect of marl applied to lands that do not contain a sufficiency of organic remains?
6. What is the effect of marl on the fertility of lands?
7. Where does it most abound in the United States?
8. What is it well to know before using marl?
9. How do we ascertain the quantity of carbonate of lime contained in a soil?
10. What advantage does marl generally possess over lime?

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#### LESSON VI.

##### MARL AS AN AMELIORATOR (CONTINUED).

36. IN the preceding lesson, we have made known the different species of marl, and also the means of distinguishing them. The question now to be examined is, to which species of earth is each kind particularly suited?

37. In general, as marl is only employed on account of the carbonate of lime it contains, it is without effect upon calcareous soils, unless the object is an amelioration by clay. The action of the farmer, as regards the amelioration of calcareous as well as other soils, depends upon the object that he wishes to attain.

38. Calcareous marl is that which agrees best with clay soils. Clayey marl and marly clay are best suited to gravelly and sandy lands; but the great quantity that it is often necessary to employ in this case leads to such expense as not always to permit the farmer to make such ameliorations.

39. In case that it is desired to employ calcareous substances on light lands, they should generally be used in small quantities; for these soils are naturally disposed to dryness, and to decompose manures; whereas, as we have seen, the reverse is the case with stiff lands.

40. Marl properly so called suits, as it were, every kind of soil, giving porosity to the clayey and compactness to the silicious.

41. Though marl is adapted to the amelioration of certain soils, it does not follow that it is fertile in itself. On the contrary, a soil containing too much of it would possess the defects of lands too highly calcareous, and it could only be rendered productive by unusual quantities of manure.

42. Marly earths favor the vegetation of certain plants that can serve as indicators to the farmer in search of marl.

43. We have just demonstrated that the action of marl depended upon its composition, and that of the soils to which it is applied. As to the quantity that should be employed, it is subordinate to three principal circumstances, namely: 1. The nature of the soil. 2. The nature of the marl. 3. The durability desired for the amelioration. This durability depends not only on the quantity of the marl to be employed, but also upon its richness. Generally, from twenty to sixty double-horse cart-loads are used; but soils on which marl is used only for its clay require a much larger quantity.

44. That marl may be effective, the soil must not be

wet. Though calcareous substances correct the defects of lands that retain water, it is when these defects proceed from their composition, and not from their situation.

45. It is generally in autumn that marl is hauled upon the land, because then it becomes rapidly friable from the effects of rain and frost, and can be more easily and evenly spread.

#### QUESTIONS.

1. Does marl agree with calcareous soils?
2. What species of marl should be employed on calcareous soils?
3. What species should be used on gravelly and sandy lands?
4. Should marl be used in large quantities on light lands?
5. To what soil is marl, properly so called, best adapted?
6. Is a marly soil fertile in itself?
7. Are there certain plants that by their presence indicate the existence of marl?
8. On what does the action of marl depend?
9. On what does the quantity of marl to be employed depend?
10. Does marl improve wet lands?
11. At what time is marl usually hauled out?

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#### LESSON VII.

##### CLAY AND SAND AS AMELIORATORS.

46. It is important here to correct an error frequently met with in works that treat of the improvement of the soil. Almost all of them recommend clay as an ameliorator of sandy soils, and sand for clay soils. Here again practice is in contradiction to theory, and has proved that clay and sand can not serve as ameliorators one to the other, as they will not combine; or at least they do so with great difficulty.

47. Let us examine the effect that each of these bodies is destined to produce upon the different soils. Sand ought to act upon soils in which clay predominates; for

these soils, being generally too compact, and consequently too hard, require the application of substances tending to lighten them ; and sand, as we know, possesses this property in a high degree, when it enters in a sensible proportion into the composition of a soil. But to produce this effect, it must be combined with the other elements of the soil ; for where it is merely mixed with the soil, it does not loosen it.

48. In fact, the experiments that have been made with sand prove that it has a constant tendency to descend through the arable surface, and that it reaches the sub-soil without having acted. It does not enter into the molecules of clay to form but a single body with them ; it does not then prevent these molecules from remaining agglomerated among themselves ; and consequently it loosens very little, if any, stiff clay soils.

49. But suppose even that the mixture of sand and clay was advantageous, this means of amelioration would be impracticable, on account of the immense quantity of sand required, and that it would be necessary often to renew, from its tendency to sink to the sub-soil.

50. It is only where a clay soil is based upon a sandy sub-soil, that it would be advisable to seek to mix the last with the first, by means of deep ploughing ; and this should be done gradually, by setting the plough deeper each time the field is worked. The increase in depth should be gradual, in order to give the mineral parts of the soil and sub-soil time to adhere and combine, as it were, among themselves.

51. Another means of ameliorating clay soils is to submit the superficial crust of the arable layer to the action of fire. Particles of the clay are hardened by the heat, and produce the same effect as gravel and sand. But this method of loosening the land is liable to the same objection as that by means of sand ; the calcined particles being

harder than the rest of the clay, are finally separated from it, and pass into the sub-soil. It has, however, the advantage of sand in being cheaper. (We will explain the process of calcination under the head *Paring and Burning*.)

52. Ploughing at the proper season, the application of lime, and a sufficient quantity of manure, are the best means of ameliorating stiff soils. As the action of frost usually renders these lands more friable, they should be broken up in the autumn.

53. The same reasons that prevent the improvement of stiff lands by means of sand, hold good against the improvement of sandy lands by the use of clay. There are, however, but few cases in which the improvement of purely gravel or sandy lands will pay at all.

#### QUESTIONS.

1. Can sand and clay serve as mutual improvers?
2. Why is it that sand does not render stiff lands more friable?
3. What other reason is there for not using sand as an improver of **stiff** soils?
4. In what cases would it be proper to mix sand and clay?
5. Is there not another method of improving stiff soils?
6. What are the best means to improve stiff land?
7. Why should not gravelly and sandy lands be improved by the application of clay?

## CHAPTER II.

*Stimulants.*

## LESSON IX.

## ASHES.

54. AMELIORATORS, as we have seen, do not exercise a direct influence on vegetation ; they are generally destined to modify the nature of the soil, by rendering it lighter or more compact (see Nos. 6 and 7). There are other substances again which, without modifying in most cases the texture of the soil, exercise a direct influence on vegetation, by exciting the organs of plants to draw a greater quantity of food than they otherwise would from the soil and the atmosphere. These substances are called *stimulants*.

55. Sometimes a stimulant has also the property of modifying the texture of a soil ; in this case it may be called a *stimulating ameliorator*. Some kinds of ashes come under this head ; and it is for this reason that we treat of them immediately after the ameliorators.

56. We give the name of ashes to the residuum left by the combustion of organic substances of vegetable or animal origin. The efficacy of these ashes depends, in a great measure, on the elements of which they are composed. The principal kinds employed are wood, turf, and coal ashes.

57. Wood ashes are the most valuable, and more generally used. They are formed of salts, of earths, and metal-

lime oxydes.\* The smaller the quantity of earths and oxydes contained in ashes, the greater is their value. Slaked ashes produce a better effect than the unslaked.

58. There is a great analogy in the action of ashes and lime. Like lime, they are best upon soils that are not calcareous, and upon those on which the carbonate of lime is the most effective. They loosen and increase the fertility of compact soils; but it is only in favorable situations, in the vicinity of cities, that they can be procured in sufficient quantity for this purpose. But in all cases they must be well spread.

59. Ashes appear to agree better with *well-drained* moist lands than with those that are naturally dry. As is the case with calcareous ameliorators, they should never be considered as manures; for they, on the contrary, hasten the exhaustion of the soil, by forcing the plants to take from it a greater quantity of nourishment.

60. Ashes are exceedingly beneficial to almost all crops; and in the vicinity of cities they are eagerly sought after, and used to an extent only limited by the supply.

61. Ashes are very generally recommended to ameliorate meadow-lands, applied to which, they enable the better grasses to compete successfully with moss, rushes, and other noxious plants. This is, however, not always the case.

#### QUESTIONS.

1. What is the difference between ameliorators and stimulants?
2. What is a stimulating ameliorator?
3. On what does the efficacy of ashes depend?
4. From what are ashes principally made?
5. Of what are ashes composed?
6. On what does their value depend?

\* The salts contained in ashes are, the carbonate of lime, the carbonate, the sulphate, and hydrochloride of potash. The earths are, silex, alumine, and magnesia. The metallic oxydes are, iron, and manganese.

7. Upon what soils are ashes of the most value ?
8. With what kind of land do they best agree ?
9. Should they be used as manures ?
10. What is the effect of ashes applied to meadow-land ?

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## LESSON IX.

### PLASTER.

62. PLASTER, as we have seen, is composed of sulphuric acid and lime. It is also called gypsum; but this last name is that by which the stone or rock is designated, before it is ground into plaster.

63. The manner in which plaster acts, and its value, have long been subjects of controversy among agricultural chemists; some contending that it serves as a direct food to certain plants (Johnson), others that its utility consists in its power of absorbing the gases, and holding them in contact with the roots of vegetables (Liebig).

64. It is sufficient, however, to state here, that it is a forcible stimulant to many cultivated crops, quickening, in a remarkable degree, the vital energies of plants.

65. On some soils the action of plaster is scarcely perceptible; but as it is a cheap substance, and of easy transportation and application, it should always be tried. Professor Johnson has ascertained, by analysis, that an ordinary crop of clover or sainfoin will yield per acre from one and a half to two hundred weight of sulphate of lime. This is precisely the quantity usually applied per acre in those parts of the country where plaster is in most general use.

66. Plaster should be sown broadcast in calm weather, when the dew is still upon the grass, at the rate of a bushel to the acre.

67. Plaster seems to act most readily upon corn, clover,

peas, tobacco, etc. It has been recommended to whiten the floors of stables, to prevent the escape of the ammonia from the urine and manure.

68. The application of plaster to timothy meadows is of doubtful utility, as it encourages the growth of the clovers at the expense of the other grasses.

69. Plaster must not be confounded with other calcareous ameliorators. These last act upon the soil by rendering it fit for any crop, whereas plaster in no way changes the nature of the soil.

#### QUESTIONS.

1. What is plaster?
2. How should it be applied?
3. What quantity to the acre?
4. Why is it of doubtful utility on timothy meadows?

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### LESSON X.

#### PARING AND BURNING.

70. As yet, this is a means of amelioration little used in the United States. Its effects are very similar to those of calcareous substances, and in some localities it may be less expensive.

71. The object of this process is to render active all inert organic substances; it will consequently be of little use on lands containing but little vegetable matter.

72. The operation of paring is usually done in dry weather, in spring or summer. The surface or sod is turned up with the spade or plough, to the depth of three inches; the sods are then set on edge to dry, and when dry are disposed in heaps, in a shape favorable to combustion. Dry brush is then put under them, and slow fires kept up, until the whole are reduced to ashes.

73. There are very few processes more beneficial to old meadows than this, as it destroys thoroughly all noxious plants, and vast quantities of insects. A good dressing of manure should follow this operation in the second year, on account of the stimulating effects of the operation on vegetation.

#### QUESTIONS.

1. What are the effects of paring and burning?
2. What is the object to be attained?
3. When and how is the operation performed?
4. Why is it advisable to apply a dressing of manure a year after the process?

## CHAPTER III.

*Manures.*

## LESSON XI.

## FORMATION, COMPOSITION, AND ACTION OF MANURES.

74. ALL substances, both liquid and solid, of vegetable or animal origin, that by their decomposition fertilize the earth by serving as food for plants, are called manures. Thus, a crop of clover turned in by the plough, as it decomposes, furnishes a supply of manure of vegetable origin. The remains of dead animals, on the other hand, furnish manure of animal origin.

75. Manures may be divided into several classes: 1. Ordinary manure, a mixture of animal and vegetable substances. 2. Animal manure, strictly of animal origin. 3. Vegetable manures, as green crops turned under, straw, etc.

76. The value of manures depends upon their nature. Those of animal origin are usually exceedingly active, and of little duration. Among vegetable substances, those most valuable as food are also most valuable as manure.

77. The continual application of purely vegetable manures will not bring land up to the highest degree of fertility. They must be aided by animal manures, which, by means of the azote which they contain, exercise upon the soil a peculiar influence.

78. Though in general the development of plants is greatly favored by the application of manures, yet there are cases in which they will do more harm than good, if great attention is not paid to their condition and mode of

application. Thus, the liquid manure from the stable may burn the plants to which it is applied, if it has not been fermented and mixed with a due proportion of water.

79. Other manures again, though beneficial to the growth of plants, are often injurious by introducing and encouraging the growth of weeds that are afterward found difficult to extirpate. This is more commonly the case with *unfermented manures*.

80. The vast importance of manure to the farmer is too generally acknowledged to make it necessary here to argue the question. The profits of the farmer depend upon the quantity of manure that he applies to his crops. It is very evident that the amount of labor required to produce a crop is the same for poor as for rich land; and yet what a difference in the yield!

#### QUESTIONS.

1. What is manure?
2. How may manures be classed?
3. Are they of equal value?
4. What are the most valuable vegetable manures?
5. Will vegetable manures alone give to the soil the highest degree of fertility?
6. How are manures sometimes injurious?
7. On what do the profits of the farmer principally depend?

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#### LESSON XII.

##### MANURE (CONTINUED).

81. MANURE is a mixture of the excrements of cattle with stable-litter. This is the most important species of manure to the farmer, as it is generally that which he can manufacture most easily.

82. To enable himself to make the necessary quantity of manure, the farmer should keep a quantity of stock pro-

portionate to the size of his farm. In this respect, however, it is difficult to lay down any general rule, and say that so many acres require so many cattle; because the quantity of stock that a given quantity of land will support depends as much upon the quality of the land, and local causes, as upon the number of acres.

83. In the production of manure, the quantity of stock is not the only thing to be studied; all the animals on a farm should not only be fed, but well fed; and the quantity of food that they will require depends upon their size and species. Besides, when the manure is thrown out in heaps from the stable, its value may be greatly affected by its management.

84. The excrements of animals are not entirely composed of the residuum of the food that has passed through them; they contain also certain particles belonging to the bodies of the animals. These particles are, in greater or less quantity, dependent on the fatness of the animal; when the beast is poor, there will be fewer of these animalized particles that increase the value of the manure.

85. Hence we may easily understand the great difference in the value of manures accruing from well-kept cattle, and those that are barely kept alive. If the farmer contents himself with feeding his cattle on substances of difficult decomposition, and containing but little nourishment — as, for instance, straw — this food will pass through their bodies without undergoing any great change, and without being animalized, in consequence of the leanness of the beast, brought about by such a diet.

86. If the quality of the food affects the quality of the manure, so does the manner of keeping cattle affect its quantity. Cattle are usually kept in two ways; at large in pastures, or in stables. This last method, if possible, should be preferred; of course, allowing the animals to run out sufficiently for exercise. Sheep are, however, an

~~SAFETY~~ to this rule, as they thrive much better in pastures.

87. When animals are pastured, there is a great loss of manure. Without taking into account the manure lost, the pasture suffers much in wet weather from the poaching of the hoof. It is generally thought that those meadows yield most on which the afterswath (that is, the grass that grows after the crop of hay is made) is never depastured. Those farmers that keep their cattle up (soil them) contend that they get four or five times as much manure as they do when the animals are grazed ; but the advantages of soiling often depends upon local circumstances, climate, price of labor, etc.

#### QUESTIONS.

1. What is manure ?
2. What must the farmer do to obtain the necessary supplies of manure ?
3. Can fixed rules be established on this head ?
4. Do excrements contain anything more than the remains of food ?
5. What causes the difference in value between the manure from fat and that from lean cattle ?
6. Does the manner of keeping stock affect the quality of manure ?
7. What are the usual methods of keeping stock ?
8. Which is to be preferred ?
9. What are the objections to grazing ?

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### LESSON XIII.

#### LITTER, AND LIQUID MANURES.

88. LITTER is, in many ways, indispensable to the farmer ; it is indispensable to the health and comfort of his stock, by affording them good warm beds in winter, and maintaining them in a proper degree of cleanliness. Again, as regards the formation of manure, it is of the utmost importance ; it not only moderates the activity that

in pure dung is too great for some soils, but it renders the hauling and spreading of the manure much easier.

89. Those vegetable substances most generally used as litter are straw, leaves, weeds, etc. But straw is usually preferred, as it is a better absorbent of the liquids, and is more readily decomposed.

90. The value of manure diminishes in proportion to the quantity of litter employed after we reach a certain point; but still it is best to use it with a liberal hand.

91. Urine is the most valuable portion of manure, and should always be saved with the utmost care. It should never be applied in a pure state, as its great activity would be hurtful to vegetation.

#### QUESTIONS.

1. Why is litter of importance to the farmer?
2. What vegetable substances are usually employed as litter?
3. Why is straw preferred?
4. Does the quantity of litter add to the value of manure?
5. Is the urine of value?
6. Should liquid manures be used in a pure state?

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### LESSON XIV.

#### MANAGEMENT OF MANURE.

92. THE manure should be drawn from under the cattle every day. This certainly should be done with horses; as to fattening cattle, some feeders pretend that they fatten more kindly when surrounded with a warm atmosphere, filled with vapor. A warm atmosphere is no doubt good, but it should be pure.

93. It is not usual to haul manure immediately from the stable to the field; in the meantime, the care that is taken of it, or its management, has great influence on its quantity and value.

94. The manure-heap should be made on a spot convenient to the stables and cow-sheds; and space should be prepared, in the form of a dish or saucer, of a size proportioned to the quantity of stock kept—so situated as to catch the drainage of the stables, and protected as much as possible from the access of rain-water. This basin should be made impervious to water, if possible, to prevent the loss by infiltration of the liquid manure. In the centre a short pump is often placed, to enable the farmer to get at any time a supply of the liquid, either for moistening the manure-heap when too dry, or for spreading on his crops.

95. The length of time that manure remains in the heap before decomposition takes place, depends upon the species of animal that produces it. That from hogs enters more slowly into fermentation than that of horned cattle. The manure from horses and sheep decomposes soonest. To avoid loss by evaporation, it is recommended to sprinkle the heap two or three times a week with such substances as plaster, to fix all the volatile principles.

#### QUESTIONS.

1. When should the manure be thrown out of the stable?
2. Is it as important to clean out the cow-shed every day as it is to cleanse the horse-stable?
3. How is the manure to be managed?
4. How is the cattle-yard made?
5. Which of the manures decomposes most rapidly?
6. Which decomposes most slowly?
7. Why should plaster be sprinkled on the manure-heap?

## LESSON XV.

## VARIETIES OF MANURE.

96. THERE is very little distinction made in farming between the different kinds of manure; the employment of special manures is not as yet practised on a large scale in this country. The value of manures depends upon the quality of the food that the stock consumes, and upon the care that is taken of them. It may be useful, however, to say a few words upon each particular kind.

97. Manures may be divided into five principal classes: that from horses, that from sheep, that from cattle, that from hogs, and that from poultry.

98. Horse-manure is very active and ferments very readily. It is used by gardeners for hot-beds. It acts best upon clay soils; but its effects are not permanent.

99. Sheep-manure, when kept moist, ferments rapidly, and is of more value than horse-manure.

100. Cattle-manure does not decompose as rapidly as the preceding. It suits light lands better, and though less energetic, is more durable in its effects.

101. Hog-manure is usually very valuable; but the value is dependent on the quality of their food.

102. The sweepings of poultry-houses make a capital manure; dried and reduced to powder, they make a good top-dressing to all crops.

103. It is important that manures should undergo a degree of fermentation before being hauled out, as the seeds of weeds contained in it are thereby destroyed. As a general rule, barn-yard manure is given to the hoed crops that precede the small grains; the quantity depends upon a variety of circumstances — the nature of the soil, the crop to be planted, etc.

104. There are four modes of applying manures; in the

hill, the drill, ploughing under, and top-dressing. This last is the only one that can be applied to meadows.

105. Manure should be spread upon the land as soon as possible after it is drawn out; when left in piles upon the field, if a rain should come, the strength of the manure is washed out, and the crops would lodge in the spots occupied by the heaps of manure, and receive little benefit in other places.

106. Liquid manures are applied by means of a hogs-head on wheels, similar to those used in watering the streets of cities; and are generally used on mowing-grounds.

#### QUESTIONS.

1. Is there any great distinction made in general farming between the different manures?
2. On what, in general, does the value of manure depend?
3. How may the different kinds of manure be divided?
4. What are the peculiarities of horse-manure?
5. What is peculiar in sheep-manure?
6. What in that of cattle?
7. What in that of hogs and poultry?
8. Ought manure to be hauled out fresh, or decomposed?
9. Ought the manure to lie in heaps for a long time, in the field, before being spread?
10. How is liquid manure carried out?
11. On what is it generally used?

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#### LESSON XVI.

##### FOLDING SHEEP—ANIMALIZED MANURES.

107. THE folding of sheep, though not much practised with us, is very general in some countries, and is attended with many advantages. The system is best adapted to light, sandy lands, and to places of difficult access to the manure-carts.

108. The fold is usually made with netting or light scantling, so arranged as to be easily taken apart. The form is square. The sheep are driven in every night, and the fold is removed when the ground occupied by it is sufficiently manured.

109. Among animal manures, we may mention flesh, blood, bones, horn, poudrette, etc., as all being exceedingly valuable.

110. When a horse, or a cow, or a sheep, dies upon the farm, it should never be left to taint the air by its decay. It should be covered with mild lime, and then a heap of earth thrown over it, of some eight or ten times its own bulk. This earth becomes saturated with the fertilizing gases, and furnishes a load or two of manure. well worth the trouble of making.

111. Bones have been known and used as a manure for a long time past; and on the lighter soils, to which they are adapted, they constitute the most valuable auxiliary fertilizing substance that has yet been discovered. The bones are reduced, in a proper machine, to the size of half an inch, and strewed upon the land, at the rate of twenty bushels to the acre. The effect on favorable soils is great and lasting; and they succeed best on all light lands, on limestone soils, and on the lighter loams. On all wet lands, whether clays, damp loams, or moist gravels, they do not pay. The inference from this is, that *bones are best suited for dry seasons and climates.*\*

#### QUESTIONS.

1. When is the sheep-folding system advantageous?
2. How is it done?
3. Mention the animal manures.
4. How can the carcasses of dead animals be turned to account?
5. What is said of bones as a manure?

\* In the face of these facts, it would be incredible, were it not a matter of record at the customhouse, that people of the proverbial acuteness

## LESSON XVII.

## VEGETABLE MANURES.

112. THE ploughing down and covering in the land of the crops of green, juicy plants, to act as manure, was a practice of the ancient Romans, and is yet followed in Italy, and other parts of the old world. This mode of fertilizing suits best in the warmer climates, where vegetation is rapid and luxuriant. The plants used for the purpose are of the leguminous kinds, clover, pea, buckwheat, etc.

113. Green manures are often more costly than is generally supposed. This is proved by deducting from their value, 1. The price of seed. 2. The cost of sowing, and the rent of the land for six months. We must infer from this, that this system is only profitable in the following cases: 1. When the lands are inaccessible to carts, or very remote from the farm-yard. 2. When other manures are not to be had, except at extravagant prices. 3. When there is a want of straw, or other litter, to make manure.

114. The choice of the plants to be turned in must depend, in a great measure, upon climate. Thus, in the northern states clover flourishes; whereas, in the south the pea, in different varieties, is substituted for it. The south has doubtless many valuable acquisitions yet to make from Europe, in the way of herbaceous plants to be used both as fodder and as green manure.

115. The proper moment to turn in all plants that are used for this purpose, is at the time of blooming; for, as maturity approaches, all the nutritive principles, distributed in the different organs, combine to nourish the ovary and form the seed. This last then seizes upon nearly all

of the New-Englanders, should suffer cargoes of bones to leave Boston, to enrich the fields of a foreign and a rival nation.

the elements of nutrition that the plant contains; also, if we delay until it is completely formed, the value of the manure is lost.

## QUESTIONS.

1. What are green manures?
2. What climates is the system best suited to?
3. Are green manures costly?
4. How are we to calculate the expense?
5. What plants are used as green manures?
6. How are we guided in the choice of plants to be used for this purpose?
7. At what time should the plants be turned under?

THE END.





















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